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CONTENTS

The North American Sordariaceae

By David Griffiths

Introduction

The work upon which this paper is based was begun in the year 1898; but actual preparation for a monograph of the group was not started until early in the following year. That there was need for more or less exhaustive study of the American species of the *Sordariaceae* must have been evident to any one in the least acquainted with our poorly defined forms. It was not, however, the necessities of the case nor the desire to contribute to botanical knowledge that actuated the undertaking. The stimulus arose from a desire to know something about the life-history, the method of development, and the appearance and behavior in *life* of a representative group of the *Sphaeriales*. How to secure and manipulate the plants successfully for the purpose of obtaining the desired information was a question not easily decided. The investigations of DeBary, Zopf, and Woronin gave a good basis for work, but they assisted but little so far as the securing and the treating of material was concerned. Finally, moist chamber cultures of horse and cow manure collected in former years in the Northwest together with similar material from Ft. Lee, New Jersey, settled two questions: (1) That with the coöperation of collectors, plenty of material could be secured; and (2) That even the preparation of a catalogue of our species would necessitate the employment of cultural methods in order that the more delicate ones might not escape attention. Acting on these two suggestions, friends and botanists throughout the country were besieged for material to be used in cultures. The success met with is attested to by the following list of contributors whose jovial prompt responses speak volumes for the whole-hearted generosity of American botanists. Early in June 1899, letters, reading substantially as follows, were addressed to about twelve individuals. Others were asked to contribute material later:

Dear Sir: Desiring to continue my study of the *Sordariaceae*, I am under the necessity of calling on friends to assist by supplying the necessary material for the work. I, therefore, take the liberty of addressing you on the subject, and trust that I may not be encroaching too much on your valuable time.

As you well know, the various species of the family grow mainly on the manure of herbivorous animals, although they are often found on other decaying materials. It is my desire to secure from your locality ten or fifteen samples of dung of the horse, ox, sheep, goat, and rabbit especially, and any others that may be conveniently secured. These samples should be wrapped in separate papers and labeled with such notes as are usually taken by the collector. I shall be all the more pleased if you collect samples having some of these fungous forms upon them; but do not spend any time attempting to find such specimens. I simply ask you to furnish me the material whether there is anything on it or not; but be sure that it is old—the older the better. Old dry pellets such as can be picked up in any pasture or meadow are what are desired. I will doubtless be able to cultivate one or more species of this group of fungi from every such sample which you will send.

Trusting that you will be able to assist me and that I am not presuming too much, I am, etc.

Old material was especially mentioned in the letters because experience had taught that it is the most productive when placed under proper conditions for the development of these fungi. This is probably due to the fact that crops produced by successive intervals of moisture load the substratum, as it were, with spores so that each successive crop is heavier than the previous one.

The following friends and botanists contributed material from the localities after their names: H. J. Banker, Proctor, Vt. and various localities in New York state; Elam Bartholomew, Rockport, Kan. and Gunnison, Col.; L. W. Carter, various localities in eastern South Dakota; Professor John Dearness, London, Ont.; Rev. C. H. Demetrio, Emma, Mo.; Professor F. S. Earle, Auburn, Ala. and Lincoln county, N. M., also several specimens collected by Professor C. F. Baker at Hermosa, Col.; J. B. Ellis, Newfield, N. J.; Professor M. J. Elrod, Missoula, Mont.; Professor L. S. Frierson, DeSota, La. (contributed by request of Professor W. E. Taylor); E. W. D. Holway, Decorah, Ia.; W. H. Long, Austin, Texas; Professor J. R. Towne, Aberdeen, S. D.;

Professor S. M. Tracy, Biloxi, Miss.; Professor A. A. Tyler, Tucson, Ariz.; Professor L. M. Underwood, Kingston, R. I.; Percy Wilson, Bronx Park, New York City; Professor E. O. Wooton, Mesilla Park, N. M.

Besides contributing material nearly every person mentioned in the list has aided me in other ways. Some have contributed valuable notes and suggestions, others type specimens for examination. Acknowledgments are also due Dr. C. B. Plowright and Mr. E. S. Salmon for valuable aid, the former for the contribution of type material, and the latter for like service and also for opinions regarding types deposited in the Kew herbarium.

The illustrations are referred to with an apology. No attempt at artistic arrangement has been made. If they show facts of form and structure, they will serve the purpose intended and at the same time be all that time and artistic ability would warrant. The original plan contemplated illustrations of such species only as had not been hitherto figured; but as work progressed, many figures were so inaccessible, a few so inaccurate, and all drawn to such varying scales that it was decided to figure anew all forms studied, for the purpose of convenient comparison. Unless otherwise specially stated, all drawings are made to the same scale; that is, perithecia are magnified 35, asci 230, and spores 310 diameters. An exception should be noted in the case of the last plate which has been prepared after my removal to another location where the same optical combinations were not available. All drawings were outlined with the camera lucida, and, with the exception noted above, the same combinations were used for like structures. This arrangement, it is believed, will secure a better basis for comparison than could otherwise be obtained. It is to be understood that certain features of the illustrations could not be easily represented by the use of the camera lucida. For instance, the hairs of the perithecia are drawn quite diagrammatically and are represented by a single stroke of the pen. The paraphyses were invariably drawn free hand from camera lucida drawings made of small sections usually near the base and apex of the filament. However, all perithecia, asci and spores, have been outlined by the aid of the camera. The text figures are mainly copies of illustrations gleaned from various sources and introduced for

the purposes mentioned in connection with each case. The illustrations of *Poronia,* however, are original and are introduced simply to emphasize certain relationships which are spoken of in the text. In the great majority of cases, the figures were prepared from living material, which fact has both advantages and disadvantages. It has the advantage of being more truthful, but the disadvantage of being less usable in some cases where many of the characteristics are lost by desiccation; for it is in the dry condition that the majority of observers see these plants. It would have been highly desirable, indeed, to have prepared illustrations in detail of the mature ascus of each species, showing not only the arrangement of the spores as has been done, but the arrangement of the appendages envelopes and epiplasm as well, but neither time nor artistic ability was at hand to accomplish this desired end. In all cases the envelopes and appendages are shown distended as they appear after remaining in water a short time.

It is very much to be regretted that type specimens could not in all cases be preserved. But owing to the method adopted for securing the plants this was simply out of the question. It is true that microscopic mounts have been prepared in triplicate in what seems to be the best method, but such specimens are very far from satisfactory and of very doubtful duration. It is hoped that the illustrations will in a measure compensate for this deficiency.

Whatever shortcomings this paper possesses must be attributed either to the author's lack of time or to inability. For no better facilities could well be offered than those furnished so magnanimously by both Columbia University and the New York Botanical Garden, which possess types of the majority of the North American species of this family, besides being rich in the collections of Messrs. Ellis, Peck, Langlois, Ravenel and others. While the responsibility for the work and its consequent conclusions rests with the writer, the influence of able counsel is acknowledged in no perfunctory manner. The mature experience, ready advice, wide acquaintance, and genial companionship of Professor L. M. Underwood have been sources of encouragement during the progress of the investigation and have aided and assisted in the completion of the work in many ways.

DISTRIBUTION

No region which has been explored by the mycologist has failed to furnish a large number of species of this family. Spegazzini* has reported a large number of species from the South American countries; Fries* and Karsten,* from the Scandinavian regions of Europe; Phillips,* Plowright,* Cooke,* and Vize,* from the British Isles; Zopf,* Zukal,* Winter,* and others from Central Europe, especially Germany; and Saccardo * and others from Italy. As would be expected, each of these regions furnishes species which have not thus far been found in the others; but a striking similarity is apparent in this portion of the flora of all the regions which have been thoroughly studied; and, judging from my own researches, further study will reveal still further similarity. An inspection of the following table and a comparison of it with Rabenhorst's Kryptogamen-Flora, Saccardo's Sylloge, and other works will reveal the fact that many species which are only casually reported and even some of those said to be rare in Central Europe are among our most common forms. There are indications that the reports are incomplete, and that the rarity is due to a lack of acquaintance with the group rather than to a lack of occurrence.

Many of the species reported in this paper have never been collected out of doors in this country, although they will almost invariably be found in abundance if cultures are made in a moist chamber. This peculiar coincidence is due to the extreme delicacy of the plants which does not permit their development except under the most favorable conditions of moisture. When drouth conditions recur again, they are so collapsed and disfigured as not to be recognized except by the most careful observation and expert knowledge. The substrata on which the plants grow are collected almost invariably in a perfectly dry state which is the least promising condition for their detection. As an illustration may be mentioned *Pleurage vestita* which is reported as rare in Germany and has hitherto been recorded, so far as my knowledge goes, from but one locality. It appears to be common all over this country. Again, *P. zygospora* is reported from Italy alone, but Professor Thaxter's observations as well as my own indicate that it is

* See Bibliography at end of paper.

of very common occurrence all over this country. Although these two species, *P. vestita* and *P. zygospora*, have been found no less than a hundred times in my cultures from different parts of this country, only once or twice has it been possible to secure even a few stray perithecia on material fresh from the field. It is no wonder then that the species are considered rare. For but few people indeed go to the trouble of looking for them at all, much less of making cultures for the purpose of finding them. It is probable therefore that many species which are reported rare in German fungus literature will be found to be as abundant there as they are in this country when proper methods are employed to bring them to light.

The following schedule will show in tabular form the similarity of the species of the group reported from Europe and from this country, and indicate the distribution by states as far as the same has been investigated.

There has not been sufficient study of material from a wide enough range to enable one to venture any conclusions with reference to altitudinal distribution, but nevertheless certain peculiarities observed in this connection are of considerable interest. *Sordaria bombardioides* appears to be a high altitude species. The first collection of it in this country was evidently made by Dr. Harkness on Mt. Shasta. The record on the Hicks specimen from Michigan does not indicate the locality. It is one of the most common and conspicuous highland species in Montana. While at Summit, Mont. in August 1900, no less than 100 specimens of this plant were found at an altitude of 5000 ft. and upward. In the same locality *Hypocopra merdaria* was equally as common and conspicuous, while *Sordaria Montanensis* was very frequent and easily distinguished on the natural substrata. *S. alpina* has appeared in no less than a dozen cultures from the same locality, but in no case was it found and recognized until the material was cultivated.

Attention should also be called here to the frequent appearance of the stromatic genus, *Hypocopra*, in the semi-arid regions. True, we have one record of *H. merdaria* from Mississippi, but it is very strange that it should not appear in any of my cultures from the Eastern and the New England States. Messrs. Ellis & Everhart report *H. equorum* from New Jersey. Mr. Ellis's only specimen

	Vermont.	Rhode Island.	New York.	New Jersey.	Alabama.	South Carolina.	Louisiana.	Texas.	Missouri.	Mississippi.	Arizona.	New Mexico.	South Dakota.	Iowa.	Kansas.	Montana.	Wyoming.	Colorado.	California.	Michigan.	Ohio.	Indiana.	Massachusetts.	British Columbia.	Ontario.	Europe.
Sordaria bombardioides.																+			+	+						+
" minima.				+																						+
" hippica.						+																				
" macrospora.								+																		+
" fimicola.	+		+	+	+			+	+	+	+	+	+	+	+	+					+				+	+
" humana.			+	+			+						+													+
" hyalina.				+						+			+		+											
" Montanensis.																+										
" alpina.																+										
" seminuda.																+										
" discospora.		+	+	+						+			+		+	+										+
" leucoplaca.		+	+	+	+	+				+			+			+		+								+
" philocoproides.				+																						
Pleurage anomala.			+																							
" Arizonensis.											+	+														
" taenioides.		+	+	+	+			+	+	+	+		+													
" anserina.	+		+	+			+	+	+		+	+	+		+			+				+			+	+
" tetraspora.																	+									+
" minuta.		+	+	+	+			+			+		+		+			+								+
" curvula.			+	+	+			+			+		+		+			+								+
" minor.															+											
" amphicornis.			+	+																					+	
" superior.																+										
" fimiseda.			+	+									+												+	+
" erostrata.								+			+		+		+	+										
" Ellisiana.				+																						
" arachnoidea.			+	+																						+

	Vermont.	Rhode Island.	New York.	New Jersey.	Alabama.	South Carolina.	Louisiana.	Texas.	Missouri.	Mississippi.	Arizona.	New Mexico.	South Dakota.	Iowa.	Kansas.	Montana.	Wyoming.	Colorado.	California.	Michigan.	Ohio.	Indiana.	Massachusetts.	British Columbia.	Ontario.	Europe.
Pleurage zygospora.			+	+			+	+	+				+		+								+*		+	+
" vestita.			+	+			+	+	+		+	+	+					+								+
" Californica.																			+							
" albicans.			+	+	+								+													+
" brassicae.																			+							+
" longicaudata.					+		+	+							+											
" decipiens.	+	+	+	+	+			+		+	+	+	+		+	+									+	+
" Kansensis.								+			+		+		+											
" multicaudata.										+			+													
" lutea.			+	+																						
" heterochaeta.																+										
" Dakotensis.				+	+			+					+		+											
" curvicolla.			+	+	+											+										+
" collapsa.			+		+																					
" pleiospora.			+	+	+					+																+
" adelura.					+																					
Hypocopra gigaspora.																								+		
" amphisphaeroides.															+											
" equorum.													+		+	+		+								+
" violacea.															+											
" Dakotensis.													+													
" merdaria.										+	+		+		+	+		+								+
" parvula.																+										
" rostrata.											+															
Delitschia didyma.			+										+													+
" eccentrica.								+		+																

* Reported by Dr. Thaxter.

	Vermont.	Rhode Island.	New York.	New Jersey.	Alabama.	South Carolina.	Louisiana.	Texas.	Missouri.	Mississippi.	Arizona.	New Mexico.	South Dakota.	Iowa.	Kansas.	Montana.	Wyoming.	Colorado.	California.	Michigan.	Ohio.	Indiana.	Massachusetts.	British Columbia.	Ontario.	Europe.
Delitschia leporina.				+																						
" Marchalii.				+									+					+							+	+
" furfuracea.															+	+		+								+
" Winteri.	+	+		+				+		+	+		+		+	+										+
" vulgaris.			+	+	+																					
" apiculata.													+													
" polyspora.											+															
Sporormia minima.	+		+	+			+	+			+	+	+		+	+		+		+					+	+
" chrysospora.														+												
" intermedia.	+		+	+				+		+	+		+		+	+		+							+	+
" leporina.			+	+				+			+	+				+		+							+	+
" lata.														+												
" pulchella.													+													+
" megalospora.		+	+	+	+						+	+	+		+	+										+
" tuberculata.				+							+															
" Kansensis.															+											
" chaetomioides.										+	+															
" Dakotensis.										+			+													
" Americana.																		+								
" corynespora.														+				+								+
" fimetaria.	+							+		+			+		+											+
" herculea.		+	+	+				+																		
Sporormiella nigropurpurea.				+																						

from this locality, doubtless the one diagnosed, as well as the one figured by Mr. Anderson, has been carefully examined, but nothing has been found which the writer can call this species. Sunken perithecia of *Sordaria fimicola* are present in considerable numbers and these are covered with a crusty layer which was the result of the drying of the slimy covering of the substratum. Professor Peck reports *H. fimeti* from New York. Aside from this latter and the very doubtful case quoted above, the stromatic forms appear to be most abundant at least in the dryer portions of the country.

The entire absence of such forms as *P. zygospora* and *P. vestita* in the higher altitudes of Montana is also very noticeable. It is of course understood that the above observations are only tentative and are based on examinations of only about 50 cultures from the higher altitudes in the vicinity of Summit.

METHODS

The material which was contributed by botanists and friends from various regions as described in previous pages was cultivated mainly between October, 1898, and January, 1901. The cultures were made in large moist chambers, eight inches wide and two and a half inches deep. Several samples from the same locality were usually placed in the same dish, each being dipped in water for a few moments after which it was placed upon several layers of moistened paper and surrounded by it except above. After standing for about an hour after this treatment, the samples were again dipped in water for an instant and then returned to the moist chambers. This amount of moisture was usually found sufficient to keep the cultures in a vigorous growing condition for about four weeks. If they began to dry out too much the substrata were again dipped in water, or often a little water was sprinkled upon them.

It was learned by experience that it was necessary to surround each sample with paper because spores from one would otherwise be ejected upon the other, and it would be difficult after ten or fifteen days to determine on which substratum the particular species originally occurred. The paper also served to retain moisture, and in many cases furnished a substratum for the development of not

only species of the group in question, but many other interesting fungi, more especially species of the genus *Chaetomium*. *Sordaria fimicola* and *Pleurage anserina* appear especially well adapted to a paper substratum, and probably in no less than a half dozen instances fine and more nearly pure cultures were obtained on the papers than on the original substratum. Indeed, these two species have been collected on a paper substratum by several individuals.

The first examination of the cultures occurred within twenty-four hours after their preparation as described above. This gave a record of all species occurring on the material when sent in. Sometimes good things were found at this time, but more often the perithecia observed were in no condition for study. The next critical examination occurred about five days later. In the meantime species of the *Agaricaceae* which developed in abundance were removed each morning. After this the cultures were examined every second day until finally discarded. No culture was continued longer than eight or less than four weeks, the average being continued about six weeks.

Each species cultivated in this way was carefully studied, described, measured and figured from the first living specimens obtained. At the same time 3 to 6 permanent mounts were made in either glycerine or 2-per-cent. chrome alum. Subsequent observations often required that both figures and descriptions be modified as a better knowledge was obtained of the species variations. The final descriptions as they appear in this paper were rewritten from these notes, slides and drawings, with careful attention, of course, in all published species, to the diagnoses given by others.

Many methods were employed in making permanent microscopic mounts, but two were finally adopted which appeared most successful and expedient. In no case has anything been found which will preserve the gelatinous appendages of the spores, nor is it at all probable that anything can be found which will preserve the more delicate ones, for they disappear in water or salt solution in a few minutes almost completely. At first, cells were prepared on the slide for the reception of the mounting fluid and the object, but this was soon dispensed with as cumbersome and unnecessary. The object was mounted in the one case, in a drop of two per cent. aqueous solution of chrome alum on the flat slide, sufficient pres-

sure being placed on the cover to rupture the perithecia, the superfluous liquid being wiped off; the cover was then sealed immediately with marine glue. In the other case the objects were mounted in water and arranged as desired when a drop of dilute glycerine was placed at the edge of the cover. Such mounts were allowed to stand for two or three days before sealing. The glycerine mounts are less liable to loss owing to imperfect sealing than the others; but they have the disadvantage of showing less detail, which is highly objectionable with such delicate structures.

Rough cultures such as those described above, although furnishing the ordinary facts required for taxonomic purposes were not of sufficient purity and ease of manipulation for some features of the investigation. It was, therefore, necessary to resort to other means of culture, suggestions for which were obtained mainly from the works of Zopf and Pfeffer.

As stated in a previous paper,* the first approximately pure cultures were made on a substratum of filter paper soaked in various decoctions. Sometimes decoctions of ash leaves or horse manure was used, at other times prune or apple juice. In many ways the most satisfactory culture substratum was prepared by soaking thin slices of the trauma of *Polyporus betulinus* with some of the decoctions given above. This was found especially good for the development of *Sordaria fimicola* and *Pleurage curvula*. In preparing this culture the dry sterilizing oven was never allowed to reach a temperature of over 135° C., because of the danger of charring the mycelium. This temperature when continued for 45 minutes was found sufficient for sterilizing purposes. The decoction was sterilized by the ordinary fractional method. In making my first cultures great difficulty was experienced in keeping out spores of *Mucor*. From the nature of the substratum on which the fungi grow naturally, it was impossible to keep out bacteria; but on paper and *Polyporus* cultures these did not interfere very much, the moulds being by far the most troublesome. The most successful method of securing the spores of the fungi free from mould spores consisted in washing a single perithecium on a glass slide in several changes of distilled water, the water being applied drop by drop and absorbed with blotting paper as it ran down the

* Bull. Torr. Club, 26: 432–444. 1899.

inclined slide. Of course, all instruments, slides and covers were carefully sterilized in the flame of a spirit lamp. After the washing, the perithecium was crushed in a very small drop of water on the slide. This caused the spores and asci to escape in a bunch through the thin membrane. They could then be gathered up by a forceps or needle and transferred to the culture directly. Such precautions usually resulted in sufficient purity to insure a good crop of the fungus. The cultures were by no means pure but they were of sufficient purity so that the fungus could combat successfully with the bacteria.

It was a long time before spores were obtained with sufficient cleanliness to enable me to grow them on agar-agar. Six successive cultures were made in duplicate at one time on *Polyporus* with the utmost precautions; but when the spores from these cultures were transferred to agar-agar the experiment was unsuccessful on account of the bacteria attached to the spores. At last, after studying the method of spore ejection, the securing of clean spores was a very simple matter. Cultures, as described above, were prepared in Petri-dishes or in the ordinary short stentor dish on paper or *Polyporus*. When the perithecia became mature and began to eject their spores, the cover was removed, and the edges of the dish wiped carefully with a cloth moistened in a saturated aqueous solution of corrosive sublimate. A new, freshly sterilized cover was now placed over the culture for twenty-four hours or less as the case required. Inasmuch as the asci stretch to the ostiolum before they rupture, the spores are ejected without coming in contact with the substratum or the perithecium at all. When caught on the freshly sterilized cover, therefore, they are clean and may be removed to the agar-agar culture with sterilized needles. If the operation is skilfully performed the culture will usually be free from bacteria. *Sordaria fimicola* was the species worked with mainly and the method proved well adapted.

Much time has been spent in making preparations from agar-agar cultures. The whole process, however, has thus far proven as fruitless as it is fascinating. Excellent serial sections of *Sordaria fimicola* have been obtained but it cannot be said that they show anything of importance. On this account it was deemed advisable to devise some method whereby the plants could be

studied on the substratum on which they grow without being disturbed. With careful manipulation this can be accomplished in an agar-agar culture very conveniently if precautions are taken regarding the securing of clean spores.

The method which has proven most successful with me consisted in treating a very thin film of the agar with the fungus growing upon it in the same way as serial sections are usually handled. Cultures were made in nutrient agar-agar in an ordinary Petri-dish. In the bottom of the dish was placed one or more microscopic glass slides and sufficient agar-agar poured in to make the thinnest possible film over the slide. Clean spores were planted usually near the center of the slide. In about four days the cultures were ready for the study of early perithecial development. Much detail can be made out by direct observation of the living material, but in order to make permanent mounts considerable patient work is necessary.

By running a scalpel around the slide, it can be removed from the culture together with the film, and placed directly in the fixing fluid which one desires to use. A saturated aqueous solution of corrosive sublimate or Flemming's weaker solution have proven most satisfactory with me. After fixation and washing the preparations were stained in either iron haematoxylin or Flemming's triple. They were then dehydrated and mounted in balsam.

It is quite a difficult task to carry such a thin film of agar through the different solutions, because it is not fastened like the ordinary serial sections. It cannot be handled in the staining dishes ordinarily used but must be kept in a flat dish which will admit the glass slide. The young fungous hyphae retain the stains more tenaciously than the agar, consequently a reasonably clear background with stained hyphae can be obtained. The retention of the gentian in the Flemming method is very difficult on account of the slowness with which the film of agar dehydrates. A counter stain of orange G is very desirable with iron haematoxylin.

DEVELOPMENT

While many of the details of the development of the fruiting conditions of these and closely related species have been worked

out by DeBary,* Brefeld,* Zopf,* Woronin,* Harper,* and Nichols,* there are many features especially connected with uncommon forms which have not been touched upon. It has not been the object of this investigation to go into many of the details of development, yet some features of it have been studied with sufficient result to warrant at least a preliminary report of some features of the process at this time. It will be the object, therefore, in the following pages to record such observations as are deemed not sufficiently emphasized in accessible literature, with simply enough of the well-established facts to make a continuity, but no attempt will be made to give a detailed account of any of the processes.

The method adopted for the culture of the fungi in the laboratory has enabled me to determine within very narrow limits, the period of development of many of the species recorded here. By keeping careful record of the time the cultures were started and again that at which mature living perithecia were found, the period of development was secured within very narrow limits. It must be fully realized however that the results given in the following table represent approximate conditions only, and this for very obvious reasons. The only precise method of determining the period of development would be by means of pure cultures. This has been resorted to only in case of *S. fimicola.* The results in all other instances are subject to errors arising from two sources—the difficulty of ascertaining the precise time of maturity, and the imperfection of the observations. At first thought it may appear perfectly easy to determine the former and one usually does so by the color of the spores, but as has been shown on another page this is very unreliable because in many of the species the spores actually germinate and grow before they have either the color or shape of what is ordinarily considered a mature spore. Woronin, for instance, found that the young hyaline cylindrical spores of *P. fimiseda* grow immediately on being released from the ascus. My own observations confirm this phenomenon for this species as well as for *P. coprophila,* while in *S. fimicola,* where the spores are ellipsoid from their inception, they have been seen to germinate and grow within the ascus while they were yet in the early olive-

* See Bibliography at close of paper.

green stage. While the test of maturity adopted here has been the usual one of color, it is fully realized that this is a rather arbitrary criterion, but one which is accompanied by such phenomena as spore ejection which probably never takes place before maturity. On the other hand, the spores become dark and opaque in many species some time before they are ejected, while in others (*P. longicaudata*) it is very difficult to find dark brown spores in an unruptured ascus. Regarding inaccuracy of observation it may be stated that the error here is but slight. Inasmuch as the cultures were examined at most every second day and usually every day, the error arising from infrequent observations would be under forty-eight hours in one case and under twenty-four in the other. In many instances, whatever error might occur has been corrected by repeated observations on material from various localities.

The periods of development for all the species upon which data have been collected are shown on opposite page.

In all instances where more than one observation was made, the shortest period found is quoted. Sometimes this was found to be the same for several cultures, but in others a difference of two or three days occurred, owing to differences in temperature at the different seasons of the year and also to imperfection of observation. The shorter periods given in the table represent the most accurate results, and it is my opinion that we should look with great suspicion on any period which extends over twenty days.

As *Sordaria fimicola* grows very readily, cultures were grown almost continually from July, 1899, to June, 1900, with some rather interesting results. The spores of this species as well as those of *S. humana*, *Pleurage curvula*, *P. minuta*, and others, grow immediately on being removed to favorable conditions, usually within twelve hours from planting. Studies made in Van Tieghem cells show that all the above species germinate by the protrusion of a small globular mass of the content of the spore through the germ pore as described and figured by Brefeld,* Miss Nichols* and others. From this globular mass the strands of the mycelium proper arise. Regarding growth of young immature spores see subsequent pages.

* See Bibliography at close of paper.

Name of Fungus.	Date of Starting Culture.	Date of Maturity.	Period of Development.	Number of Records.
Sordaria bombardioides.	Nov. 18	Dec. 2	14 days.	12
" minima.	Nov. 28	Jan. 14	47 "	1
" fimicola.	Feb. 7	Feb. 16	9 "	32
" humana.	Mar. 24	Apr. 2	9 "	1
" hyalina.	Mar. 28	Apr. 5	8 "	2
" Montanensis.	Mar. 24	Apr. 14	21 "	1
" alpina.	Nov. 23	Dec. 4	11 "	1
" seminuda.	Nov. 23	Dec. 10	17 "	2
" discospora.	Mar. 24	Apr. 12	19 "	2
" leucoplaca.	Mar. 24	Apr. 12	19 "	1
" philocoproides.	Jan. 3	Jan. 20	17 "	1
Pleurage Arizonensis.	Jan. 28	Feb. 24	27 "	2
" taenioides.	Mar. 24	Apr. 2	9 "	7
" anserina.	Mar. 24	Apr. 2	9 "	10
" tetraspora.	Nov. 26	Dec. 12	16 "	2
" minuta.	Mar. 28	Apr. 10	13 "	3
" curvula.	Mar. 24	Apr. 2	9 "	7
" superior.	Nov. 28	Jan. 6	39 "	1
" fimiseda.	Mar. 24	Apr. 3	10 "	1
" erostrata.	July 4	July 13	9 "	4
" Ellisiana.	Dec. 8	Dec. 27	19 "	1
" zygospora.	Mar. 24	Apr. 3	10 "	5
" vestita.	Jan. 28	Feb. 14	17 "	3
" albicans.	Mar. 25	Apr. 10	16 "	3
" longicaudata.	Mar. 28	Apr. 9	12 "	3
" decipiens.	Mar. 24	Apr. 2	9 "	11
" Kansensis.	Mar. 24	Apr. 2	9 "	4
" multicaudata.	Jan. 24	Feb. 9	16 "	1
" heterochaeta.	Nov. 26	Dec. 11	15 "	1
" Dakotensis.	Mar. 24	Apr. 10	17 "	2
" curvicolla.	Mar. 28	Apr. 14	17 "	2
" collapsa.	Feb. 8	Mar. 30	50 "	1
" plicospora.	Mar. 28	Apr. 14	17 "	1
Hypocopra equorum.	Nov. 15	Dec. 20	35 "	1
" merdaria.	Feb. 19	Mar. 6	15 "	2
" parvula.	Nov. 26	Dec. 15	19 "	1
" rostrata.	Jan. 28	Mar. 3	34 "	1
Delitschia didyma.	Jan. 24	Feb. 24	31 "	1
" Marchalii.	Mar. 24	Apr. 26	33 "	1
" furfuracea.	Mar. 24	Apr. 10	17 "	2
" Winteri.	Mar. 24	Apr. 5	12 "	5
Sporormia minima.	Jan. 28	Feb. 18	21 "	9
" intermedia.	Jan. 28	Feb. 15	18 "	7
" leporina.	Mar. 28	Apr. 9	12 "	3
" pulchella.	Jan. 28	Mar. 5	36 "	1
" megalospora.	Mar. 24	Apr. 5	12 "	3
" tuberculata.	Jan. 10	Mar. 12	61 "	1
" Kansensis.	Feb. 19	Mar. 27	36 "	1
" chaetomioides.	Mar. 24	Apr. 2	9 "	1
" Dakotensis.	Mar. 24	Apr. 26	33 "	1
" fimetaria.	Mar. 28	Apr. 7	10 "	3
" herculea.	Mar. 28	Apr. 11	14 "	2

The large number of specimens of *S. fimicola* on hand from various regions induced me to attempt a determination of the period of vitality of the spores. These experiments were conducted in drop cultures in Van Tieghem cells. Eight cultures were prepared in duplicate, one set in water, the other in a decoction of horse manure. The difference in the solutions did not affect the germination in the least. The cultures were started on the 10th of May. The oldest spores to germinate were collected in October, 1896. A more vigorous growth than the latter could not be desired, even the olive-green spores growing in abundance and in an apparently normal manner. The next oldest specimens were collected in March, 1894, but they failed to germinate. Several specimens bearing an older date all failed to grow. It is not known to what conditions these specimens from various sources have been subjected. Doubtless some of them have been subjected to laboratory conditions which would entirely destroy their vitality. All that can, therefore, be claimed for the experiments is that they give as much light on the subject as the material at hand will permit; and simply offer a suggestion for future investigation when the proper material shall have been secured. That spores will remain in a normal condition over three and one-half years under the desiccating influence of laboratory temperatures has been shown.

Another set of experiments begun on the second of March and continued for seventy-five days, although furnishing no information of great consequence, are quite interesting. Eight crops were obtained during this period, and each crop was obtained from spores of the next preceding one, the first being started from Vermont specimens. Some of the cultures were made on the trama of *Polyporus betulinus* and others on filter paper, and all cultures were made from spores which had been ejected by a natural process on the cover of the culture dish.

Many experiments intended to determine the influence of external conditions on development were unsuccessful owing to accidents of one form or another, and the time limit prevented their repetition; but certain observations are worth recording. The most peculiar results were obtained from cultures made in the dark. As is well known *Sordaria fimicola* has perithecia which are

more or less sunken, and the degree to which they develop within the substratum is very variable under natural conditions. The portion of the perithecium which develops below the surface is more or less covered with hairs which, on account of their development within the substratum, are seldom seen. In the dark, the perithecia assume a more superficial development and are completely covered with these mycelial strands which assume the form of short wavy hairs, brown below and white toward their tips, giving the whole structure a grayish appearance. This hairy condition is sometimes met with in cultures made in the light, if a considerable amount of moisture be present so as to cause the development of perithecia on the glass at the edge of a thin film of moisture. It is, however, never so strikingly developed as in the dark.

Cultures made on agar-agar fertilized with a very weak decoction of horse manure, were inverted and placed in the light of an ordinary laboratory and in the dark respectively, darkness being produced in this case by wrapping the culture dish in black cloth and placing it in a pasteboard box. The perithecia asumed an upright or oblique position, generally growing in either case with their beaks projecting into the agar; in fact, the perithecia were often completely buried. When mature, the spores were forced out in a small globular mass. Many of the perithecia, when examined after about three weeks, were found entirely empty. Not a spore could be found in them, showing that the process of ejection had been complete. In this case the agar was very transparent and the perithecia which were grown in the dark, especially, were so slightly colored as to readily reveal the outline of any spores that might remain within them. The period of development was from two to three days longer in darkness than in the light.

But little can be added to the oft-repeated accounts of the development of the perithecium. A constant watchfulness has been exercised to discover signs of sexuality but no conclusive results have been reached. The methods described for handling the mycelium intact on thin films of agar have given some fine preparations of very young perithecia, and many structures similar to those which have been described as sexual organs, have been

found. But it is very difficult to demonstrate the actual fusion of elements. One point regarding the development of the perithecium has been very interesting. It may be a matter of common observation, but it has not been discussed, at least to any great extent. The perithecium which originates from a few erect coiled branches of mycelium early becomes a closed globular conceptacle with neither beak nor ostiolum. (*S. fimicola.*) The beak is developed later by a process of unequal growth, as it were, at the apex of the globular perithecium and finally the thin wall is broken, forming the ostiolum. The latter process is beautifully illustrated in *Sporormia minima*. If the perithecia of this species in various stages of development are carefully isolated from the substratum, some of them will be found with short delicate light-colored papilliform beaks, but with no ostiolum whatever. In two cases I have seen the membrane over the ostiolum actually ruptured by an expanding ascus membrane. Of course it is understood that the hyphae of which the perithecia are formed do not entirely lose their identity in many species. As has been pointed out by Woronin they may often be traced through the beak especially, and often appear to be continuous with the short paraphyses which fill the narrow channel leading to the ostiolum. In *Sporormia minima* the wall of the perithecium is at most three or four cells in thickness and the continuity of the hyphae is entirely lost, while in *Pleurage fimiseda* there occurs a wall which consists of as many as ten or twelve cells in thickness and is differentiated into three distinct layers.

In spore development, the greatest interest attaches to the genus *Pleurage* on account of the peculiar appendaged condition of the spores. No effort will be made here to go into the cytological aspect of this subject for the perusal of which the reader is referred especially to the works of Harper * and Dangeard † on closely related forms.

In all species of this genus wherein primary appendages occur the spore goes through a most peculiar set of transformations: at first it is a short cylindrical hyaline straight or curved cell whose contents do not differ materially from that of the ascus in

* Jahrbücher wiss. Bot. 30 : 249. 1896. Annals Bot. 13 : 507. 1899.

† Le Botanist, 5 : 245. 1897.

which it is found. This cylindrical cell grows for a time in all dimensions, but before long begins to enlarge greatly at the upper end where the protoplasm of the entire spore will soon be found. As soon as this migration of protoplasm from below is completed, a partition wall is formed, separating this now ellipsoid upper portion from the lower cylindrical one. This process results in the formation of a single fertile cell with delicate hyaline homogeneous appendage at its lower end. This constitutes the primary appendage spoken of throughout this paper, and is really an abortive cell or possibly only an abortive portion of a cell; the determining of this point would necessarily involve the behavior of the nucleus. One may often see on rupturing the perithecium that the wall laid down between the fertile and abortive cells is very delicate compared with the remainder of the spore boundary, for the slightest disturbance often ruptures it and allows the protoplasm to flow out of the upper cell into the now empty lower one. This phenomenon can be seen very readily in such forms as *P. decipiens*, *P. vestita* and *P. fimiseda.* The same thing is shown in a capital manner in *P. zygospora.* Here the connecting filament between the two fertile cells of the spore is of the same nature as the primary appendage in the other species; but this species deserves special treatment on account of its unusual form. Here the young spores are approximately crescent-shaped, and their contents resemble that of the ascus as before. A tremendous increase in length takes place before there is any appreciable terminal enlargement. About the time that this has begun to manifest itself, the filaments themselves are comparatively longer than the spore-bearing portion of the ascus; and have, therefore, become twisted in their growth so as to display a spiral arrangement within the ascus. When enlargements begin they appear at each end of this long filament instead of at one end of a comparatively short one as in the other species of the genus; and the protoplasm from the filament moves toward either end, forming two fertile cells instead of one as in other species. This results in the production of sixteen fertile cells within the ascus. Inasmuch as the filament joining two cells soon dissolves, the ascus appears to be, and is in effect a 16-spored ascus. On this account Saccardo has transferred the species to the genus *Philocopra.* When the method

of development is taken into consideration it appears better to consider it an 8-spores ascus. But this opens up the question as to the definition of a spore into which it is best not to enter here.

An inspection of *Pl. 18. f. 8* and *17*, will show that here as in all of the Ascomycetes, there is a considerable portion of the protoplasm of the ascus unused in spore formation. In *Pleurage* this is comparatively large in amount, and from it are developed the gelatinous appendages of the spores. In the other genera of the family it forms gelatinous envelopes instead. All stages of gelatinous appendage formation may often be traced in a single perithecium of such forms as *P. taenioides* or *P. fimiseda*. At first they are not visible at all, but as development proceeds they gradually appear as short lash-like projections on the ends of the spores. At this time they may be very distinct at the proximal end, while the distal one gradually fades away into the general protoplasmic reticulum of the ascus. As the appendages develop, the protoplasm decreases in quantity and gradually assumes a more homogeneous consistency, until at maturity, the granularity so characteristic of the early stage has almost if not quite disappeared. The appendages of a spore are almost never straight, but on the contrary curve around among other spores and their appendages, thus holding them together firmly but delicately to facilitate the process of spore ejection as described further on.

SPORE DISSEMINATION

Intimately connected with the structural and developmental peculiarities discussed in the preceding pages is the function of spore dissemination. To gain an adequate conception of this function one must necessarily be familiar with such phenomena as spore development, spore appendages, structure of perithecia, osmosis, turgidity and numerous other physical and structural details intimately connected with the process itself. So far as development and structure are concerned the preceding pages enable us to proceed directly with the question in hand. Owing to differences in the method of scattering the spores adopted by different groups of the family, it will be necessary to discuss the dissemination in the different genera more or less separately.

The classification of the group as here adopted is determined in

a large degree by the method by which the spores are scattered. This feature can be best understood by a tabular arrangement of the genera depending upon this function. The scheme which follows, although showing in brief the salient features of the subject, requires the elucidation of the subsequent description for its complete appreciation. It must be borne in mind that the scheme is not perfect—there are apparent exceptions which will be discussed later; but these are of such a nature as to prove rather than disprove the importance to be attached to this feature of the classification of the group. Should one then attempt to classify the group on the characteristics afforded by this function an arrangement something like the following would result:

A. Asci without a functional internal membrane; asci stretching at maturity.
- I. Asci opening by an apical pore.
  - 1. Ascus containing a complicated apical structure which colors blue with iodine. *Hypocopra.*
  - 2. Asci not containing such a structure. *Sordaria.*
- II. Asci opening by the breaking off of a non-elastic thimble-shaped portion of the ascus apex. *Pleurage.*

B. Asci containing an internal membrane; asci non-elastic at maturity.
- I. Membrane opening by an apical pore. *Sporormia* and *Sporormiella.*
- II. Membrane opening by the breaking off of a lid or thimble-like portion of the apex which is often clearly marked out by a constriction. *Delitschia.*

An inspection of the above outline will indicate a clear distinction between the genera recognized here with reference to this important function, and their characters will become more apparent as we proceed.

In the discussion which follows it will be advantageous to take up the groups in a slightly different order than they appear above. For certain reasons which will become apparent later, it will be more convenient to discuss first the genus *Pleurage.*

There occur in this genus several species which are especially favorable objects for our present purpose because the walls of their perithecia are so thin and delicate that, with transmitted light, the asci and spores can be distinctly seen without rupturing the perithecium. *P. curvula*, *P. minuta*, *P. tetraspora*, and *P. curvicolla* are the most favorable; while *P. vestita*, *P. decipiens*, *P. zygospora*, *P. Kansensis*, and *P. longicaudata*, may be employed but with less satisfaction.

If a fully mature perithecium of one of the first groups mentioned above be carefully removed from the substratum, and mounted in the ordinary way in a drop of water, no difficulty will be experienced in recognizing that the asci stand at different levels —they are not all the same length. On the other hand an immature perithecium when examined in the same way will have all the asci of approximately the same length, and all of them will extend upward about one third of the length of the perithecium. If examined at the proper time the asci and spores will occupy a short cylindrical space in the center of the perithecium and appear black and opaque. Pressure placed on the cover-glass in either of these two cases will cause the perithecial wall to burst and allow the asci and paraphyses to escape in a bunch through the side or bottom. Never by this kind of rough treatment do the asci escape through the ostiolum. On the contrary a break occurs in the wall at or below the middle, allowing the escape of not only the organs mentioned above, but also of a quantity of ascogenous tissue as well. There is a line of easy separation between the ascogenous tissue and the outer wall of the perithecium, which gives away and allows the escape of asci and long paraphyses which surround them more or less attached together. After being removed from the perithecium in this way, the asci change their shape very materially in a short time. Instead of maintaining the normal cylindrical or clavate outline they will become very wide and sac-like without an appreciable stipe in *P. curvula* and closely allied species, but with a very long narrow stipe in *P. zygospora*. An examination of the apex of the ascus in nearly every case will reveal the fact that it does not materially change its shape. The portion of the ascus wall which stretches is, therefore, that which lies below a thimble-shaped portion of the apex. Another phenomenon to be noted here is the constant attachment of the spore mass, together with whatever protoplasmic content the ascus may have, to the apex of the ascus. In examinations of this kind the asci are lying horizontal in water, and the spores as observed follow the apex of the prolonging ascus. More will be said about this phenomenon later.

Returning now to the mature unruptured perithecium mounted in water under a cover-slip, we note again that the asci are at dif-

ferent elevations. If the apex of the uppermost ascus be placed on a certain mark on one side of the micrometer scale, it will be found to move slowly but very uniformly toward the ostiolum. The most prominent part of the ascus is the mass of dark spores which like those of the other preparation follow the apex in the same relative position as in the unexpanded normal ascus. Careful manipulation of the light will enable one to trace the outline of the entire ascus wall, however, as far down as the tops of the unstretched asci. This is facilitated by the fact that in stretching, the asci force the paraphyses which fill the upper portion of the perithecium into a smaller space, causing a difference in refraction between the ascus and the surrounding region—the space within the greatly expanded ascus appearing more homogeneous and less opaque than that immediately surrounding it. On account of the darkened character of the region immediately surrounding the ostiolum, the progress of the apex of the ascus can not be followed for a short distance in the average perithecium; but when a good culture is at hand which has been developed in a moist chamber in a moderately lighted room, perithecia can be selected with very slight blackening of the apex. In these the stretching ascus can be under continuous observation. When the apex of the ascus reaches the ostiolum it extends outward but a short distance. In all cases observed the upper spore always protrudes, but it never clears the opening before the ascus ruptures and forces the spores out. In the species studied most carefully, *P. curvula* and *P. minuta*, the break in the ascus always occurs between the non-stretching apex and the elastic lateral walls. In this way a thimble-shaped portion of the ascus apex is cut off.

The separation may be complete when the thimble-shaped apex is pushed forward with the spores, or partial when it remains attached to the ascus by one side or becomes rubbed off when the old wall contracts and goes back into the perithecium. It must be remembered that the ascus remains attached all the time that it is stretching; and that after rupturing the elastic walls contract to approximately their normal length again. Woronin was the first to offer an explanation of the fate of the old ascus wall. That it goes back into the perithecium again there is no question, but after twenty or thirty asci have been seen to erupt, it is with

extreme difficulty that any of the old membranes can be found on opening the perithecium. Woronin * states that they are reabsorbed. Whether he is correct or whether the old membrane partially disintegrates and becomes pushed out by subsequent expanding asci does not appear clear to me. If the old ascus wall is observed in water outside of the perithecium it gradually disappears while one is studying it, and it is difficult even then to say what becomes of it. At any rate, it deliquesces in a very short time and this probably occurs in the perithecium as rapidly as in water outside of it.

The same author also calls attention to the fact, which has been repeatedly although not constantly observed in the progress of my investigations, that the paraphyses are much more abundant in the old perithecia. It is well known that there is a considerable period during which the successive asci mature. Some are very young and probably contain but a single nucleus when others are mature. This is especially true in such forms as *P. fimiseda* which was the species especially studied by Woronin, as well as in *P. coprophila*, *P. zygospora*, *P. decipiens*, and *P. anserina*. It does often appear that when the perithecium has nearly spent its force and contains but few asci, that the paraphyses are more numerous than in the earlier stages of development. It appears as though the paraphyses are developed as occasion demands and that when the perithecium ceases to produce new asci their place is occupied by new paraphyses which enable the few remaining asci to elongate and reach the ostiolum in a normal manner. It is evident that this would not be true in case the space was left vacant, for the asci would simply enlarge laterally as they often do when allowed to expand in water. In other words they would not be held by lateral pressure in such a way that they would be obliged to stretch in length more than in width.

When the collector obtains a specimen of this group, it is of value to him if he has secured it at a time when the perithecia are full of asci. For then by rapid drying they are prevented from disseminating their spores. On the other hand the plants may be collected already dried suddenly in nature at a time and under such conditions that the spores could not be ejected. But it

* Abhand. Senkenberg. naturforsch. Gesell. (Frankfort), 7: 339. 1869–1870.

often happens that the perithecia are empty or contain but few loose spores. The transformation of the perithecium to the latter condition has been repeatedly observed in cultures. *P. decipens*, *P. vestita*, and *P. zygospora* are especially favorable species for illustrating this point. If the cultures are kept in suitable condition for the development of the plants, they will continue growing for a long time but will finally all die, when there may be found among the débris many perithecia with no spores at all in them. Usually there are, however, a few found, but only a few in any case. In such cases the paraphyses have all disappeared also. It is in younger stages when the vitality is just beginning to wane that the paraphyses appear abundant. Later, like all the remainder of the more delicate tissue of the perithecium, they deliquesce. They also become very numerous when the cultures dry gradually.

Returning again to the stretching asci, there are several important points to be considered in connection with them. Zopf * first called attention to the fact that but one ascus ruptures at a time. In observations of certainly not less than a hundred perithecia of the *P. curvula* group, no deviation from this rule has ever been observed. They may be found at all elevations up to the very narrow neck of the perithecium, but as soon as one ascus ruptures another takes its place in regular succession and there never appears to be any confusion regarding which shall precede. Even in this genus, however, the machinery sometimes becomes clogged for some reason and the spores are simply pushed out of the ostiolum forming a globular mass on the beak. But this phenomenon is much less common in this genus than in some of the others.

The frequency with which the asci erupt, according to my observations, varies greatly in perithecia treated exactly alike. Observations on this point have been made especially with *P. minuta* and *P. curvula*. The first extended observation was made on the fourth of November, 1899, with *P. minuta*. Perithecia were carefully removed from the substratum with needles, mounted in a drop of water and covered with a thin, light cover-slip. After several mounts were made one was obtained which appeared to be in just the right condition for study. This was allowed to eject

* Zeitschrift gesammt. Naturwissen. (Halle), 56. 1883.

three asci after being mounted before any records were made. Continuous observations were then made with the same perithecium for three hours and twenty minutes. The following figures indicate the time at which successive asci were ruptured: 10:25, 10:46, 11:35, 12:09, 12:53, 1:45, giving periods between eruptions as follows: 21, 49, 34, 42 and 52 minutes, respectively. The plants had been growing in laboratory temperatures and the perithecia were mounted in water of the same temperature. These observations were evidently not normal, so other observations were made later with the same material which showed an eruption in from 15 to 25 minutes at first and gradually increased as the time of the experiment was protracted. An attempt was then made to observe the phenomenon on the substratum under a low power. This could be done except with great difficulty only for a short time, owing to the evaporation of moisture from the cultures. Sufficient data were obtained, however, to corroborate previous observations. In one case three successive asci erupted in 22, 18 and 28 minutes, respectively. A series of three observations on Colorado specimens of the same species gave an average of 16 minutes for the first three asci erupted after being mounted in water. In one case three asci erupted in 20 minutes. The best that can be said then regarding the time is that it varies usually from 15 to 25 minutes; and that it is probably very materially influenced by temperature and moisture as well as by the age and general vigor of the plants.

The distance to which the spores are ejected is now to be considered, for the determination of which two methods have been employed. The perithecia may be mounted in water as described above and the distance measured directly with the micrometer scale. The distance in air may then be computed. This method has not proven satisfactory in my work, probably owing to the interference of the water with the physiological action of the plant. The other method consists in placing portions of the substratum in a tall moist chamber and catching the spores on the cover of the vessel. Adhesive paper was at first used, but this is entirely unnecessary because the spores are moist and have more or less gelatinous substance clinging to them in the way of appendages that they adhere readily to glass. The distance of the cover, on

which spores are found by microscopic examination after the lapse of a few hours, from the substratum, indicates the distance to which the spores are discharged. Of course the experiment must be repeated a great many times and the distance of the surface which collects the spores must be varied in such a way as to locate the extreme distance to which spores are ejected. This has been done a great many times with *P. curvula.* In the majority of cases the substratum with the growing plant was placed in a fruit jar and ordinary white paper was supported at proper distances to collect the spores. In six experiments the distance varied between 5 and 9 cm.; the greatest distance being obtained in the last trials. It is quite probable that the later observations are the most accurate for it was discovered after two or three trials had been made, that the apparent distance to which the spores are thrown upward depends upon the conditions of the growth of the plants. As has been observed a great many times by others, Zopf especially,* these fungi are strongly heliotropic, curving in a short time under unequal illumination in such a way as to turn the ostiolum toward the source of light. Plants grown under these abnormal conditions are evidently unsuited for the determination of distances to which spores are ejected, because they will not be thrown directly upward when the perithecia are curved. Indeed if the beak is much curved, as often happens in other species of this genus, normal action is interfered with to such an extent that the spores are simply pushed out of the ostiolum in such a way as to form a globular mass resting on and remaining attached to it. This condition was once produced in a very striking way in *P. curvicolla.* The plants were grown in a large Petri-dish, and the substratum was surrounded by paper in such a way as to admit light diagonally from above. After the first four days the position of the paper was changed in such a way as to change the direction of the light, with the result shown in *Pl. 1. f. 6.* A great many perithecia were found which had globular masses of spores on their apices. This condition, however, is usually more or less prevalent in any culture on account of the irregularity of the substratum which in itself causes more or less of an unequal illumination in cultures made within doors.

* *Loc. cit.*

To guard against errors produced by heliotropic curvatures, the plants were grown in some cases in complete darkness; in others they were placed a short distance below the window sill so that the perithecia would grow without curvature as much as possible. From such cultures the higher distances of spore ejection were obtained. It is interesting to note in this connection that Woronin, working with this same species, found a much greater distance, sometimes as high as 15 cm. This is really remarkable when we stop to consider that the perithecia do not usually measure over .7 mm. and the asci only about a third of this length.

Attention was called on a previous page to the spores remaining in the apex of the expanding ascus. This appears to be due to two factors, one of which is purely physical and the other physiological and structural. It was noted that the apex of the ascus does not stretch; inasmuch as the lateral walls do, they become separated from the spore mass and from whatever protoplasmic and gelatinous content the ascus may have, at all points except the apex. The attachment is very slight, but there is some adhesion between the appendages and the wall at this point, and it remains undisturbed until the ascus ruptures. The arrangement of the spores is usually unaffected also, as they are held in place mainly by the gelatinous appendages. The other force which assists to keep the spores in the apex of the ascus is the buoyancy of the absorbed water which causes the turgidity of the ascus. That the two forces operate is evident from the fact that the spores are heavier than water and that they follow the apex of the expanding ascus when it lies on its side in water.

In the genus *Sordaria* there occurs a different and somewhat less efficient mechanism for spore dissemination, at least this appears to be the case judging from the frequent appearance of clogging of the canal leading through the beak. (*Pl. 18. f. 14.*) The ascus stretches here as in the genus *Pleurage*, but there is less tendency to lateral extension, the asci stretching mainly in length. When a mature perithecium of *S. fimicola*, for instance, is ruptured under a cover-glass, the asci often appear with long wide pedicels, but they will be but slightly wider than the normal ascus. In every species of this genus reported for this country at least, there occurs a very characteristic ascus apex. (*Pl. 2. f. 2, 17.*)

Instead of having a cap-shaped portion of the ascus break off as described for the genus *Pleurage*, there obtains here a perforation in the broadly rounded to truncate apex, through which the spores find exit. This is not to be considered an actual opening, but simply a thin spot in the ascus wall. This is situated in a slight depression which causes the apex of the ascus to be spoken of in descriptive works as thickened.

It is impossible to watch the asci stretch here as in the previous genus on account of the fact that the wall of the perithecium is always dark and opaque. In several instances, however, spores have been seen ejected, but in no case have the asci been seen actually protruding from the ostiolum.

No special experiments have been performed to determine the distance to which the spores are thrown, but casual observation of the sides and covers of my culture chambers in which *S. fimicola* was grown has revealed distances as high as 6 cm. Inasmuch as great quantities of spores were found at this distance from the substratum the figures are probably much below the normal.

It has been stated that the mechanism appears much less efficient in this genus than in the previous one. This statement is made on observations of paper and agar-agar cultures mainly, where in some cases the majority of the perithecia were found with large bunches of spores on their apices. This condition is also common in any culture. These perithecia when studied carefully were seen to have their necks filled for a considerable distance with loose spores. These are pushed out by the pressure of consecutive expanding asci. Being covered with a viscid gelatinous substance they adhere to each other and to the apex of the perithecium forming a globular mass resting on the ostiolum. Often the spores are pushed out in a column, of the same diameter as the opening, which protrudes in a straight line or curves downward by its own weight for a distance of 5 mm. or more. (*Pl. 18. f. 14.*) This gives an appearance very similar to certain of the *Hypocreales*, especially to species of the genus *Melanospora*.

The genus *Hypocopra* has an ascus very similar indeed to that of *Sordaria*, but there remains to be described here a very characteristic structure whose function and composition are entirely unknown. From its position it is supposed to be connected with

the function of spore dissemination; but its behavior during this process is not known and the actual exit of spores from the ascus has never been observed. Zopf * was the first to describe this structure which is found in the apex of the ascus, and is easily recognized by its giving the characteristic starch-blue reaction with iodine. It possesses a definite structure and differs more or less in outline in the different species. It occurs in no other genus of this family, but according to my observations is very common if not constant in several of the genera of the *Xylariaceae*. *Poronia*, *Xylaria*, and *Daldinia* may be especially mentioned.

It appears to be in organic connection with the protoplasm of the ascus upon which it rests and by which its base is more or less surrounded by short blunt processes. Its upper portion shades off gradually into the ascus wall from which it is separated by a very indistinct line of demarkation. Laterally in several species it is prolonged into long indistinct horn-like processes which project downward. When the ascus is viewed endwise the structure is seen not to be solid, but appears as a thick ring, bounded externally by the ascus wall. The whole structure is brought out very clearly by the application of iodine which gives to it a typical starch-blue color. Occasionally in *H. equorum* the reaction with iodine has been observed to be brown in many of the asci. But the brown is a very different color from the protoplasmic brown of the remainder of the ascus. It should be described as more of a transparent umber. In *H. merdaria* faint striations may be seen in a lateral view, which are more readily seen when the color is being gradually extracted in dilute glycerine. It stains most deeply at the base and gradually fades out toward the apex and toward the lateral horn-like projections which are not colored at all except at their very bases. Zopf has given colored drawings of this structure as seen under the iodine reaction, but the definite shape and outline appears to have escaped him although he represents perfectly the upward projections of the general protoplasmic contents of the ascus. This body appears before there is any sign of spores in the ascus and grows in size as the ascus and spores develop, but it is a perfectly definite structure from its first appearance.

* Zeitschrift gesammt. Naturwissensch. (Halle), 56: 1883.

The organ when examined under a high power appears to be actually segmented as shown in *Pl. 19. f. 17*, in which five segments are distinctly shown. In this particular specimen, which is from Montana, both the blue and the brown reactions with iodine were manifest. The basal segment gave the blue reaction and the second segment a very deep brown which gradually decreased in intensity upward and finally disappeared entirely in the lower portion of the upper segment leaving the upper portion perfectly hyaline.

The behavior of this apical organ on being removed from the ascus is of great interest. In the Montana specimens this has been actually observed in two or three instances entirely accidentally, however. In *Pl. 19. f. 17, 18*, the organ is shown both before and after the removal. The upper segment will be seen to have diminished in size, the three middle ones to have increased slightly in all dimensions, but the lower one has become tremendously enlarged. These observations, while of considerable interest, furnish only presumptive evidence regarding the function of the organ.

Dr. D. T. MacDougal has recently suggested to me, rather reservedly, that the blue coloration in this structure may possibly be due to the presence of a mixture of amylose and pectin compounds such as are described by Pfeffer* for the epidermal cells of *Saponaria officinalis*, *Arum Italicum* and other species. The suggestion is instructive, but no positive statement can be made regarding it at present. The fact that there occurs a brown reaction at times in some species would indicate that the composition is by no means constant.

Further investigation of this apical body of the ascus is necessary. A careful study of its development and occurrence in other genera of the Sphaeriales may have an important bearing on the question of relationship. Indeed the genus *Hypocopra* appears to have a close affinity to some of the genera of the *Xylariaceae*.

In passing from the genera which have spores with one cell to those which have spores with three or more cells there occurs an entirely different method of spore dissemination; as far as my observations go, the asci here are not elastic at all. Not a single

* Plant Physiology, English ed. 473.

instance has been found in which the asci were thought to be stretched in the least. Osmotic action, however, obtains here as in the other genera at the time of maturity; but the asci rupture without stretching in much the same manner as those of *Pleurage* after stretching. The ascus ruptures transversely by cutting off a portion of the apex. The line of rupture varies in different species and indeed it is not constant in the same species. It may occur near the apex when a small thimble-shaped segment of the ascus apex is cut off as in *Sporormia intermedia*, or it may occur farther down as in *S. herculea*. (*Pl. 2. f. 9.*) After the rupture of the ascus in the latter species the lower attached portion may be distinctly seen thrown into irregular convolutions and folds, while in the former, as well as in many of its closely related species, the corresponding portion appears to hold its shape almost perfectly after the rupture.

As soon as the wall of the ascus in the genus *Sporormia* is broken, a second membrane appears within it. The protoplasmic contents of the ascus has formed a membrane which is indistinguishable from the ascus wall itself before the rupture occurs. This internal membrane is tremendously elastic. Several cases have been observed in which the membrane stretched five times the length of the original ascus. Sometimes the cap of the ascus is carried up with the membrane, but more often it soon becomes rubbed off and is lost. The membrane, unlike the asci of the genus *Pleurage*, does not extend much in width; it continues about the same in this dimension as the original ascus. In all the species of the genus there is not one which has transparent perithecia, so we are obliged to employ other means of studying the behavior of the asci. Fortunately here the membrane carries all of the spores entirely outside of the perithecium, *S. intermedia*, *S. leporina*, and *S. Dakotensis*. In the last named species they protrude twice or thrice the length of the spore mass beyond the ostiolum. Usually they will remain stretched to their full capacity for a short time when the apex of the membrane gives way and the whole spore mass which is held together by the gelatinous coatings is forced out, as from the ascus of *Sordaria*, through an apical perforation. Whether the apical perforation is constant in the genus is not fully determined; but it is very common at least. Uncertainty regard-

ing the point is caused largely by the fact that it was entirely overlooked in the early part of my investigation. Plate 2 will show some of the species in which it is known to occur.

When mature perithecia are ruptured under the cover-glass, the asci escape in the same manner as in the genus *Pleurage*, but here there is a much more conspicuous effect of osmosis. The asci rupture in rapid succession and the membranes stretch out with such force and such rapidity as to keep the entire field in constant agitation for a considerable length of time. It is rather exceptional, however, to find a membrane rupturing normally under such circumstances. They generally remain stretched for a time and finally either rupture at some point in the lateral wall or gradually contract again when the membrane deliquesces and disappears entirely.

The distance to which the spores are ejected in this genus has not been studied with any degree of accuracy. But judging from the case of *S. Dakotensis*, where hundreds of asci have been seen ejecting their spores in water, the force of membrane rupture here is about the same as the force of ascus rupture in the species of *Pleurage* studied. (*Pl. 2. f. 1.*)

There appears to be considerable variation in the different species in reference to the progress of the asci through the ostiolum. In *S. intermedia* two and three asci may stretch out at once. Usually one is in advance of the others, but still some portions of three will be seen moving out at one time. In *S. leporina* one at a time appears to be the rule, to which an exception has never been noticed either in this species or *S. Dakotensis*. The phenomenon has been observed but once in the first species, several times in the second, and twice in the last, with which a very thorough series of observations were made.

The rapidity with which the successive membranes appear at the ostiolum in *S. Dakotensis* is sometimes almost incredible. Several will often stretch out in a minute with perfect regularity and in absolute single file. Nearly two days were spent in studying the South Dakota specimens of this species when they became mature; the results obtained were most astonishing when compared with the genus *Pleurage*.

Observations were made the first day on three perithecia between

3 and 5:30 P. M. They were mounted in water as usual and the frequency of the appearance of asci at the ostiolum noted. The data in the three cases were as follows:

1.	30	asci	passed	out	in 7	min.
2.	25	"	"	"	" 6	"
3.	40	"	"	"	" 8½	"

Other records made were discarded for various reasons, mainly because of uncertainty. The following day a more extended series of observations were made when results were obtained as follows:

1.	30	asci	passed	out	in	7	min.	10	sec.
2.	30	"	"	"	"	6	"	15	"
3.	50	"	"	"	"	5	"	5	"
4.	30	"	"	"	"	10	"	12	"
5.	33	"	"	"	"	14	"		

The fifth perithecium was studied for 65 minutes with observations every 10 minutes of sufficient duration to determine whether the rate of ejection was constant. No variation could be detected until after 60 minutes had elapsed, and at 65 minutes the observation was discontinued. At the rate given above about 153 asci must have erupted during this time. There were a great many asci left in the perithecium at the close of the experiment.

The genus *Delitschia* has a functional internal membrane in the ascus very similar to *Sporormia*, apparently the only difference being the method in which the ascus ruptures. Instead of rupturing at an apical pore the membrane opens by a lid or thimble-shaped portion breaking off very much like the ascus in *Pleurage*. In some of the species this is clearly marked off by a constriction (*Pl. 13. f. 17*), which is only faintly visible before the rupture of the ascus, but is very distinct as soon as the membrane begins to elongate. Only a few cases of actual rupture of the membrane and exit of the spores have been observed.

In making mounts and rupturing perithecia, it often happens that the asci become severed from their attachment by the stipe becoming broken off near the base. When this occurs some very peculiar phenomena may be observed (*Pl. 1. f. 1*). The elastic membrane may push out of the narrow opening thus made in the stipe and form a long bag-like structure below the ascus proper. The spores may remain in the ascus proper, or some of them may be forced into the membrane below.

The best summary of this subject is found in the synopsis on page 32; but a few general considerations will be of value. The whole process of spore ejection is considered to be a purely physical phenomenon which has no connection with the life processes of the plant except in so far as the structures which render it possible are the result of those processes. Evidences of this have accumulated during the progress of the work. Every genus in the family shows that the asci will stretch in a normal manner after a desiccation which has rendered them entirely lifeless.

It was my practice in making moist chamber cultures to pay but little attention to the samples of the substrata until they were thoroughly moistened. At this time they were all carefully examined for perithecia of species of this family. This examination always took place within the first twenty-four hours after the cultures were started. In several instances one or more species were found, and their asci or membranes enlarged in an apparently normal manner. The phenomenon was of remarkably frequent occurrence in the genus *Sporormia*, but the same thing was often observed in studying dry specimens of any of the other genera when they had been dried at the proper stage of development. One case studied is of particular interest. The substratum on which *S. lata* was found was sent to me late in July or early in August, 1899. It was kept in a dry state in the laboratory until January, 1900, when it was thoroughly moistened and placed in a moist chamber where it remained for about twenty hours before being examined. The asci on being pressed out of the perithecium ruptured, and the membranes elongated in a manner indistinguishable from a growing plant. Several membranes ruptured and ejected their spores in water under the cover-glass. Later, membranes were found pushing their way out of the ostiola in undisturbed perithecia upon the substratum. But the rupture of the asci and the elongation of the membrane are matters of common observation in some species of the Pyrenomycetes. However, no record has come to my observation of an actual demonstration of spore ejection like this one from dead specimens.

It appears from these observations that these plants have so adapted themselves to their environment that they may be dried with impunity when they reach maturity, and that when proper

conditions of moisture reappear the spores will be ejected at a favorable time for germination. Whether this is a common practice or not can not be asserted, but that it does at times occur is without question. It is easy to conceive how such an arrangement might be of a decided advantage to the plant, whose environment is subject to great variations of moisture in short intervals of time.

Order SPHAERIALES

Family SORDARIACEAE

Perithecia superficial or deeply sunken in the substratum, and often erumpent at maturity; usually without a stroma, but when it occurs, the perithecia are sunken with projecting papilliform beaks; thin and membranaceous to coriaceous; slightly transparent to black and opaque. Asci usually very delicate, surrounded by long paraphyses or intermingled with them. Spores usually dark-colored, 1 to many-celled, surrounded by a hyaline gelatinous envelope or ornamented with hyaline gelatinous apicula. The species are entirely saprophytic and generally grow on manure.

Key to the Genera

Spores 1-celled.*
- Stroma absent.
  - Ascus perforate; spores partly or entirely surrounded by a hyaline gelatinous envelope. — I. SORDARIA.
  - Ascus not perforate, but opening by breaking off of the inelastic ascus apex; spores ornamented by secondary gelatinous appendages with or without primary ones. — II. PLEURAGE.
- Stroma present; spores surrounded by a gelatinous envelope and the germ pore elongated and lateral. — III. HYPOCOPRA.

Spores more than 1-celled.
- Stroma absent.
  - Spores 2-celled. — IV. DELITSCHIA.
  - Spores 4- to many-celled. — V. SPORORMIA.
- Stroma present. — VI. SPORORMIELLA.

The disposition of the genera corresponds most closely with the arrangement adopted by Rehm,† and differs from the later works of Schröter ‡ and Lindau § mainly in the division of the genus *Sordaria* as recognized by them. The development of the epiplasm of the ascus into a gelatinous envelope or into gelatinous apicula is here recognized as a generic character, but Lindau states, inasmuch as all gradations between the two forms are

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* *Pleurage zygospora* is an exception.

† Rabenhorst, Krypt.-Flora Deutschlands.

‡ Cohn, Krypt.-Flora Schlesien.

§ Engler & Prantl, Die natürlichen Pflanzenfamilien.

found, that all the species should be included in the same genus. This is certainly unsound reasoning, for if it were followed consistently we would be obliged to abolish much if not all of our system of classification as well as the entire doctrine of evolution. But this appears not to be the only distinction between the two genera. In all the American species at least there is a decided difference in the apex of the ascus, the genus *Sordaria* as here recognized having an ascus with an apical perforation, while in the genus *Pleurage* there is no such opening, but the ascus ruptures by the breaking off of a lid or cap-like portion.

With regard to the synonomy some explanation appears to be necessary. The name *Podospora* has been applied in recent times to the species having appendiculate spores; but two years ago Dr. Otto Kuntze * called attention to the fact that Fries † established the genus *Pleurage* on *Schizothecium fimicolum* Corda ‡ as a type. Corda's generic name being a homonym, the name given by Fries will have to stand. As stated elsewhere, it is not known now what species Corda had; it has usually been said that he had *P. fimiseda*, but Rehm quotes it as *P. curvula*? It appears to me from an examination of Corda's description and figures that there is no question but that he had one of the *P. curvula* group of species at least; but since he does not figure the asci it is impossible to decide. Since, however, he figures a species having agglutinated hairs, appendaged spores and living on dung, it seems perfectly safe to accept it as the type of the genus, although the species can not be determined with certainty.

Cesati and DeNotaris § established the genus *Sordaria* in 1863, giving a list of 16 species with *Sphaeria sordaria* Fr. at the head of the list. Fourteen of these species have been removed to other genera, one has been dropped from our literature entirely, and one, *Sphaeria fimicola* Roberg., remains to represent our present conception of the genus.

Lack of time has prevented any extended study of relationships with other groups, but a few observations are thought to be

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* Rev. Gen. Plant. 3^3: 504.

† Summa Vegetab. Scand. 2: 418.

‡ Icones Fung. 2: 29.

§ Comment. Soc. Crit. Ital. 1: 225.

worth recording at this time. Certain species of *Sporormia* show a close relationship to such forms as *Perisporium*, while *Pleurage erostrata* has a perithecium which is typical of the *Perisporiales*, but its spore appendages and other characters are identical with *Pleurage*. It is to the relationships of the genus *Hypocopra* that attention is especially called. When species of *Poronia* developed in cultures of material from South Dakota, Arizona, Mississippi, and Texas, I was particularly struck with their similarity to *Hypocopra* and came to an almost immediate conclusion that this genus of the *Xylariaceae* should be placed with the *Sordaricaeae;* further study, however, raised a doubt as to whether *Poronia* should be placed in the *Sordariaceae* or *Hypocopra* in the *Xylariaceae.*

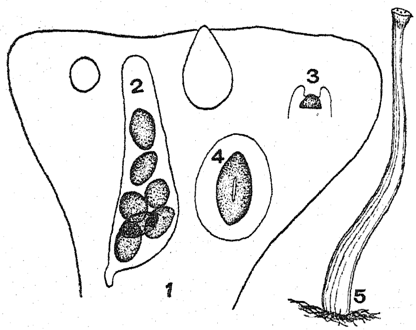

FIG. 1. *Poronia* introduced to illustrate similarity to *Hypocopra.* The species has passed for *P. oedipus*, but it is rather doubtful whether it is that species. 1, diagram of upper expanded portion of stroma × 35, from microtome sections; 2, ascus × 230; 3, apex of ascus showing apical body × 315; 4, spore × 315; 5, stroma × 2. The figures are all from Texas specimens developed in a moist chamber. The stroma is much more slender and the expanded upper portion much smaller on this account.

There is no question but the two genera are very closely related and should be placed together. An examination of the figures of *Hypocopra violacea* with the accompanying cut of *Poronia oedipus* (Fig. 1) will show clearly how closely related the two genera really are. In the first, the perithecia are completely imbedded in a stroma. All that is necessary to make it a *Poronia* is to have the stroma stalked. The points on which the two genera agree may be summarized as follows:

1. Habitat.
2. Development of a stroma.
3. Similar paraphyses.

4. Texture of perithecia.

5. Ascus with apical structure which colors brightly with iodine.

6. Spores with hyaline envelopes.

7. Spores with lateral germ-slit.

Poronia differs from *Hypocopra* in having a stipitate stroma and in developing conidia. Concerning the latter it may be said that it is of minor importance inasmuch as it is not definitely known whether *Hypocopra* produces conidia or not, and it is well known that although some species of the *Sordariaceae* produce conidia, others never do. The apical body of the ascus is a very characteristic structure and occurs according to my observations very commonly in the *Xylariaceae*.

Podosordaria Mexicana Ell. & Holway, which would naturally be looked for here, is a *Poronia* pure and simple.

I. SORDARIA Ces. & DeNot. Comment. Soc. Crit. Ital. 1: 225. 1861. Ellis & Everhart, N. Am. Pyren. 126. 1892. Winter; Rabenhorst, Krypt.-Flora, 1^2: 165. 1887.

Hypocopra Fuckel, Symbol. Mycol. 240. 1869. Saccardo, Syll. Fung. 1: 240. 1882.

Perithecia scattered or aggregated, superficial or sunken, membranous or coriaceous, dark and opaque. Asci containing an apical perforation and stretching at maturity. Spores one-celled, usually dark-brown in color and surrounded by a gelatinous hyaline fugacious covering.

Key to the Species

Perithecia not hairy or bristly.
- Spores dark-colored.
  - Perithecia coriaceous. — 1. *S. bombardioides.*
  - Perithecia membranaceous.
    - Spores small ($5 \times 8\,\mu$), subglobose. — 2. *S. minima.*
    - Spores cymbiform. — 3. *S. hippica.*
    - Spores ellipsoid, large ($15–18 \times 25–34\,\mu$), rounded at both ends. — 4. *S. macrospora.*
    - Spores ellipsoid, smaller ($11–13 \times 16–23\,\mu$), acutely rounded below. — 5. *S. fimicola.*
    - Spores obovate, acutely rounded below. — 6. *S. humana.*
- Spores hyaline. — 7. *S. hyalina.*

Perithecia hairy or bristly.
- Asci 8-spored.
  - Beak long and hairy.
    - Spores with apiculum at each end. — 8. *S. Montanensis.*

Spores with apiculum at lower end only. 9. *S. alpina.*
Beak papilliform, conical or wanting.
Hyaline envelope surrounding lower third of spore only.
10. *S. seminuda.*
Hyaline envelope surrounding entire spore.
Spores conspicuously flattened, comparatively large and subcircular.
11. *S. discospora.*
Spores comparatively small, ellipsoid to subglobose.
12. *S. leucoplaca.*
Asci 32-spored. 13. *S. philocoproides.*

1. SORDARIA BOMBARDIOIDES Awd.; Niessl, Beiträge zur Kentniss der Pilze (Brünn) 1872 *; Hedwigia, **12**: 130. 1873. Rabenh. Krypt.-Flora, **1**²: 168. 1887. Saccardo, Syll. Fung. **1**: 233. 1882. Ellis & Everhart, N. Am. Pyren. 128. 1892. *Hypocopra bombardioides* (Awd.) Sacc. Syll. Fung. **1**: 243. 1882.

Perithecia superficial, crowded and confluent at base, .5 mm. wide by 1 mm. long; thick coriaceous, chestnut-brown to black; oval, oblong or pyriform, broadly rounded above and terminating in a small papilliform ostiolum.

Asci 8-spored, cylindrical, broadly rounded above and tapering below into a short stipe, 20–30 μ × 150–210 μ: paraphyses filiform, septate, agglutinated, longer than the asci.

Spores obliquely uniseriate, oval, broadly rounded at the ends and often inequilateral, 12–14 μ × 26–34 μ, ranging from hyaline when young through yellow to dark brown and opaque: gelatinous covering prominent and swelling greatly when placed in water (*Pl. 4. f. 4–7.*)

Distinctive characters: Shape, size and prominence of the perithecia.

Dry specimens: On horse dung, Mt. Shasta, California. (Harkness); horse dung, Michigan, 1893 (Hicks); horse and cow dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

Cultivated specimens: On horse and cow dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

The wall of the perithecium swells enormously in water and then may be easily separated into two layers, an outer gelatinous and an inner more firm and rigid one. When the outer portion is removed there remains a somewhat clavate doubly papilliform body containing the spores. A 10-per-cent. solution of

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* This reference is not at hand but the next is a reprint of the original description.

caustic potash has about the same effect as water, but the action is more energetic.

The development of this species, while no more interesting than many of the other species of the family, is much more striking and readily observed. It was one of the most common species met with during the month of August, 1900, at Summit, Montana. No less than a dozen cultures of it have been made from material collected in this region. While the perithecia are described as confluent and superficial they are often found scattered as well; and the young groups almost invariably are erumpent from between the fibers of the substratum, becoming entirely superficial at maturity. The young perithecia are a dark somewhat translucent brown and become black only after maturity.

2. SORDARIA MINIMA Sacc. & Speg. Michelia, **1**: 373. 1878; Fung. Ital. *pl. 617.* 1879

Hypocopra minima (Sacc. & Speg.) Sacc. Syll. Fung. **1**: 244. 1882.

Perithecia scattered, superficial or more often with sunken base, 100–150 $\mu \times$ 150–180 μ, thin, membranaceous, dark brown to black with cellular structure usually invisible, pyriform to conical with papilliform to blunt and truncate beak; exposed portion covered with minute papillae.

Asci 8-spored, cylindrical, broadly rounded to truncate and perforate above, and slightly contracted below into a short blunt stipe, 5–8 $\mu \times$ 60–85 μ: paraphyses filiform but wide in comparison with the ascus, septate, equal to the ascus or slightly longer.

Spores uniseriate, ellipsoid to subglobose, prominently biguttulate when young but becoming indistinctly so at maturity and entirely homogeneous in age, hyaline when young, varying through olivaceous to dark brown and opaque, varying but little from 5 $\times$ 8 μ. (*Pl. 3, f. 25–27.*)

Distinctive characters: Small black papillate perithecia and small spores.

Cultivated specimens: On goat dung, Ft. Lee, N. J., Nov. 1899.

3. SORDARIA HIPPICA (B. & R.) E. & E. North American Pyren. 127. 1892

Hypoxylon equinum B. & R. Grevillea, **4**: 93. 1876.

Hypocopra hippica (B. & R.) Sacc. Syll. Fung. **1**: 247. 1882.

Perithecia springing from a thin effused white mycelium;

ostiola black, papilliform; spores short cymbiform, 15 μ long. On horse dung, South Carolina (Ravenel).

This is a very doubtful *Sordaria*, but as the description is very meager and the original specimen cannot be found, no positive statement can be made concerning it.

4. SORDARIA MACROSPORA Awd.; Rabenh. Fung. Europ. no. 954. Rabenh. Krypt.-Flora, **1**^{2}: 195. 1887. Cohn, Krypt.-Flora Schlesien, **3**^{2}: 286. 1894. Abhand. naturforsch. Gesell. zu Halle, **13**: 79–80. *pl.* 7, *f.* 4. 1873.

Pleurage macrospora (Awd.) Kuntze, Rev. Gen. Plant. **3**^{3}: 505. 1898.

Hypocopra macrospora (Awd.) Sacc. Syll. Fung. **1**: 241. 1882.

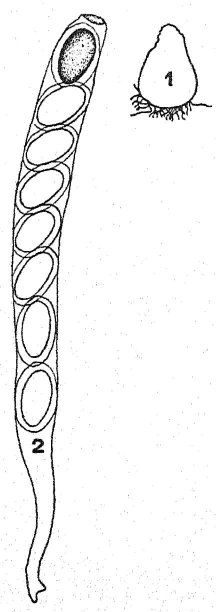

FIG. 2. *Sordaria macrospora* after Winter. 1, perithecium; 2, ascus.

Perithecia scattered and sunken with a short papilliform to enlarged globular naked beak, about 350 μ × 550 μ, pyriform, thin, membranaceous, black.

Asci 8-spored, cylindrical, broadly rounded above and contracted below into a long stout stipe, persistent, 225–280 μ × 20–25 μ: paraphyses abundant, ventricose, agglutinated, longer than the asci but not mixed with them.

Spores obliquely uniseriate, elliptical, broadly rounded at the ends, 15–18 μ × 25–34 μ: hyaline envelope prominent and swelling greatly in water.

Distinctive characters: Mainly as in *S. fimicola* but with larger spores.

No American specimens of this species have been seen. The above description has been taken from European specimens and from Winter's diagnosis. The species has been reported to have been collected in Texas by H. W. Ravenel. The specimens were named by M. C. Cooke and published in Annals New York Acad. Science, **1**: 186. 1878.

5. SORDARIA FIMICOLA (Rob.) Ces. & DeNot. Comment. Soc. Crit. Ital. **1**: 226. 1861. Rabenh. Krypt.-Flora, **1**^{2}: 166. 1887.

Sphaeria fimicola Rob. Desmazieres, Plant. Crypt. de France, no. 709; Ann. Sci. Nat. III., Vol. 353. 1849.

Hypocopra fimeti Fuckel, Symbol. Mycol. 240. 1869.*

Hypocopra fimicola (Rob.) Sacc. Syll. Fung. **1**: 240. 1882.

Sphaeria equina Fuckel, Fung. Rhen. no. 1802.†

Sordaria Iowana Ell. & Holw. Jour. Mycol. **4**: 65. 1888.

Sordaria ostiolata E. & E. Bull. Torr. Club, **24**: 458. 1897; Saccardo, Syll. Fung. **14**: 492. 1899.

Hypocopra Iowana (Ell. & Holw.) Sacc. Syll. Fung. **9**: 490. 1891.

Perithecia scattered or aggregated into a layer which forms a complete covering for the substratum, usually sunken at first and erumpent later, but they may be superficial from the first, 240–300 $\mu \times$ 325–525 μ, thin, membranaceous, with cellular structure usually plainly visible, hyaline when young, ranging through greenish to dark brown or black, pyriform with papilliform or slightly elongated, black beak which may be smooth or slightly roughened with minute papillae.

Asci 8-spored, cylindrical, broadly rounded to truncate, perforate at the apex and tapering below into a short blunt stipitate base, 16–19 $\mu \times$ 140–160 μ, rather persistent: paraphyses ventricose, agglutinated, longer than the asci.

Spores obliquely uniseriate, ellipsoid, rounded at the ends, but evidently more acutely so below, 11–13 $\mu \times$ 16–23 μ: germ pore apical, circular and situated in the lower more acutely rounded end of the spore: hyaline covering not surrounding the entire spore but having its edges attached around the germ pore, which it does not inclose on stretching. (*Pl. 3, f. 19–21, and Pl. 4, f. 8–10.*)

Distinctive characters: Dark pyriform smooth perithecia and ellipsoid spores.

Dry specimens: On horse, rabbit and cow dung, Ontario, Canada (Dearness); North American Fungi, nos. 2550 and 2749; on *Carex vulpina*, Oberlin, Ohio, March, 1894 (Jones); paper under bread culture in laboratory, Ann Arbor, Mich., March, 1894 (Johnson); horse, cow and rabbit dung, Rooks Co., Kan. (Bartholomew); horse dung, Decorah, Ia., May, 1886 (Holway).

Cultivated specimens: On horse, cow, goat, and rabbit dung in vicinity of New York City, and Ft. Lee, N. J., summer, 1899;

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* Rehm in Rabenh. Krypt.-Flora gives *H. stercoris* Fuckel, Symbol. Mycol. 241 as a synonym of this also, but in Winter's own copy of this work he has written in the margin opposite this species *macrospora*. From the measurements and description given by Fuckel it would seem that Winter is correct.

† Not seen.

horse, sheep and rabbit dung, Tucson, Ariz., Jan. 1900 (Tyler); horse, deer and rabbit dung, Mesilla Park, N. M., and vicinity, Jan. 1900 (Wooton); horse dung, Proctor, Vt., Aug., 1899 (Banker); horse dung, Schaghticoke, N. Y., Aug. 1899 (Banker); rabbit, horse, and cow dung, London, Ont., Aug. 1899 (Dearness); horse dung, Huron, Highmore and Brookings, S. D., summer, 1899 (Carter); rabbit dung, Auburn, Ala., Aug. 1899 (Earle); horse dung, Biloxi, Miss., Sept. 1899 (Tracy); horse, cow, rabbit and dog dung, Austin, Tex., Jan. 1900 (Long); horse, cow and rabbit dung, Rooks Co., Kan., Aug. 1899 (Bartholomew); horse dung, Emma, Mo., Aug. 1899 (Demetrio); horse dung, Summit and Great Falls, Mont., Aug. 1900 (Griffiths and Lange).

6. SORDARIA HUMANA (Fuckel) Awd. Abhand. naturforsch. Gesell. zu Halle, **13**: 85. *pl. 8. f. 9.* 1873. Rabenh. Krypt. Flora, **1**[2]: 166. 1887. Ellis & Everhart, N. Am. Pyren. 126. 1892.

Sphaeria humana Fuckel, Fung. Rhenani, no. 1801.

Hypocopra humana Fuckel, Symbol. Mycol. 241. 1869; Saccardo, Syll. Fung. **1**: 240. 1882.

Sordaria sphaerospora E. & E. North American Pyren. 128. 1892.

Hypocopra sphaerospora (E. & E.) Sacc. Syll. Fung. **11**: 280. 1895.

Perithecia scattered and sunken, with projecting papilliform beaks or aggregated in solid clusters and erumpent in such a way as to be completely exposed at maturity, about 350 μ × 600 μ, thin, membranaceous, dark brown to black, pyriform with papilliform to slightly cylindrical beak.

Asci 8-spored, cylindrical, broadly rounded to truncated above and tapering below into a short blunt stipe, quite persistent, 17–19 μ × 160–200 μ: paraphyses large, ventricose, longer than the asci and not much mixed with them.

Spores obliquely uniseriate, obovate, broadly rounded above and acutely so below, 14–18 μ × 21–23 μ, ranging from hyaline when young through olivaceous to dark brown and opaque: gelatinous envelope becoming very prominent in water and covering the entire spore except the circular germ pore at lower end of the spore around which it appears firmly attached. (*Pl. 3, f. 16–18 and Pl. 4, f. 14–16.*)

Distinctive characters: Dark pyriform smooth perithecia, and obovate spores.

Dry specimens: On dog and human dung, Newfield, N. J. (Ellis).

Cultivated specimens: On cow dung in greenhouse; Columbia University, winter and spring, 1899; goat and dog dung, New York City, August, 1899; pig dung, Brookings, S. D., November, 1899 (Carter); pig dung, De Soto, La., August, 1899 (Frierson).

Like two other species of this genus, *S. fimicola* and *S. humana* appear so closely related that a discussion of one necessarily involves the other. The difference between them is very slight, and it was very difficult for me at first to make a separation, although an abundance of dry material was at hand. It was only after cultures of both species were made side by side that it was really decided that they were different. But when the differences are all summed up there is only one which appears to hold throughout—the shape of the spore. About a half dozen cultures of *S. humana* were made at once under varying conditions of light, temperature and moisture in order to determine whether the forms of the spores varied, but in no case was the ellipsoid spore of *S. fimicola* seen to develop. One seems justified, therefore, in arriving at but one conclusion, that there are two species here, as have been described, although they are established on but one constant specific character.

7. **Sordaria? hyalina** sp. nov.

Perithecia small, scattered, sunken, subglobose, about 150 μ in diameter, thin, membranaceous brown, smooth, with cellular structure plainly visible: beak papilliform or entirely wanting, when the ostiolum is simply an opening in the top of the subglobose perithecium.

Asci 8-spored, cylindrical, broadly rounded or truncate, and perforate above, and contracted below into a stipe of medium length, very numerous and quite persistent, 5–6 $\mu \times$ 45–55 μ: paraphyses absent.

Spores obliquely uniseriate, ellipsoid, broadly rounded at the ends; 2.5–3 $\mu \times$ 4.5–5 μ: gelatinous covering very narrow. (*Pl. 3, f. 28–30.*)

Distinctive character: Hyaline spores.

Cultivated specimens: On cow, horse, and goat dung, Ft. Lee, N. J., and New York City, summer, 1899; cow dung, Rooks Co.,

Kan., July, 1899 (Bartholomew); cow dung, Schaghticoke, N. Y., Aug. 1899 (Banker); horse dung, Aberdeen, S. D., Sept. 1899 (Towne); cow dung, Biloxi, Miss., Aug. 1899 (Tracy).

Outwardly this species resembles *Sporormia minima* somewhat. It appears to be quite widely distributed, but it has never been met with in any great quantity. Usually only a few scattered perithecia have been found in one culture.

8. **Sordaria Montanensis** sp. nov.

Perithecia scattered, sunken, 450–600 $\mu\times$750–900 μ, thin. membranaceous, dark brown to black in color, subglobose to oval with a long black cylindrical projecting beak; all exposed portions, especially the beak, densely covered with short straight acuminate sparingly septate hairs of approximately equal length; these become gradually changed into the long flexuous rhizoids which cover the sunken portions of the perithecium.

Asci 8-spored, cylindrical, rounded or truncated and perforate at the apex, and tapering below into a long stout stipe, quite persistent, 29–32 $\mu\times$340–400 μ; paraphyses filiform, septate, slightly longer than the asci.

Spores obliquely uniseriate, ellipsoid, broadly rounded at the ends, 24–27 $\mu\times$45–51 μ tipped below by a broad, conspicuous, hyaline apiculum, and at the apex by a very much smaller inconspicuous one; the spore and its apicula surrounded by a gelatinous covering which becomes very wide and conspicuous when mounted in water. (*Pl. 3. f. 1–3 and Pl. 19. f. 13.*)

Distinctive characters: Long cylindrical hairy beak and apiculate spores.

Cultivated specimens: On horse dung, Missoula, Mont., Jan. 1900 (Elrod); horse and cow dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

This is a very striking species which is decidedly different from anything else in the genus. The spore apicula show a close relationship to the genus *Pleurage*, while the hyaline envelope, which is very pronounced, and the apical perforation of the ascus, locate it without doubt in the present genus. It occurred rather rarely in the first cultures, but abundantly in the last.

9. **Sordaria alpina** sp. nov.

Perithecia sunken, scattered, or aggregated in small clusters, pyriform, thin, membranaceous, olivaceous below but black in all exposed portions, about .5 $\times$ 1 mm., the black projecting long

stout cylindrical beak, as well as all exposed portions of the perithecium densely and uniformly covered with rather short stout abundantly septate brown hyaline-tipped straight hairs.

Asci 8-spored, cylindrical, slightly contracted and rounded above and gradually narrowed below into a long slender straight, curved or crooked stipe, $18–20\,\mu \times 270–350\,\mu$, persistent: paraphyses abundant, septate, often slightly constricted at lower septa, mixed with and much longer than the asci.

Spores uniseriate, ellipsoid, rounded at both ends, ranging from hyaline when young through olivaceous to dark brown and opaque, $12–14\,\mu \times 20–37\,\mu$, with a minute hyaline apiculum at lower end of each spore: gelatinous envelope narrow and swelling but slightly in water. (*Pl. 19. f. 4–6.*)

Distinctive characters: Small spores with one minute apiculum below and a very narrow hyaline envelope.

Cultivated specimens: On horse and cow dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

In outward appearance and habitat, this species resembles *S. Montanensis* very closely. It can be readily distinguished from the latter, however, by spore characters. The plant was cultivated upon material collected on account of the presence of *S. Montanensis.* In the cultures it was difficult to separate the two except by the more abundant development of mycelium in the latter although they occurred on distinct areas of the substrata.

10. **Sordaria seminuda** sp. nov.

Perithecia sunken, scattered or aggregated in small clusters, pyriform, thin, membranaceous, olivaceous below but black in all exposed portions, $300–400\,\mu \times 500–600\,\mu$, the black papilliform projecting beak and all exposed positions covered with short straight brown hyaline-tipped scarcely separate hairs arranged in small groups or uniformly scattered.

Asci 8-spored, cylindrical, broadly rounded and perforated above and contracted below into a long, crooked stipe, $180–200\,\mu \times 12–14\,\mu$, rather persistent: paraphyses filiform, septate, persistent, not numerous, seldom exceeding the asci in length.

Spores obliquely or vertically uniseriate, ellipsoid or often ovate, broadly rounded above but more acutely so below, $10–12\,\mu \times 16–22\,\mu$, ranging from hyaline when young though olivaceous to dark brown and opaque; lower end of spore tipped with a short hyaline cylindrical apiculum which is surrounded by a triangular hyaline gelatinous envelope extending over the lower third of the spore. (*Pl. 19. f. 10–12.*)

Distinctive character: The peculiar gelatinous covering of the spore.

Cultivated specimen: On horse dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

This species is very closely related to the genus *Pleurage* inasmuch as the spores have an apiculum which is a part of the original hyaline cylindrical spore which has been cut off in the process of development as described elsewhere. The gelatinous coating which, however, covers only a third of the spore and which is rather persistent compared with many species, together with the perforate ascus place the species in the genus *Sordaria* without any doubt.

11. SORDARIA DISCOSPORA Awd.; Niessl, Beitr. Kenntn. Pilze Brün, 1872*: Abhand. naturforsch. Gesell. zu Halle, **13**: 83–85. *pl. 8. f. 8.* 1873.

Hypocopra discospora (Awd.) Fuckel, Symbol. Mycol. Nachtrag 2: 43. 1873. Sacc. Syll. Fung. **1**: 240. 1882.

Sordaria platyspora P. & P. Grevillea, **6**: 28. *pl. 94. f. 2.* 1877.

Hypocopra platyspora (P. & P.) Sacc. Syll. Fung. **1**: 241. 1882.

Perithecia scattered, usually sunken, 220–270 μ in diameter, thin membranaceous and often quite brittle, dark brown to black and opaque, subglobose to pyriform, with short papilliform to conical black beak which is covered like the exposed portions of the perithecium with short, erect, dark brown or black hairs.

Asci 8-spored, broadly rounded to truncate and perforate above, and contracted below into a short blunt stipe, 75–130 $\mu \times$ 13–21 μ: paraphyses filiform, septate, slightly longer than the asci.

Spores uniseriate, flattened, subcircular to broadly ellipsoid in one view and narrowly elliptical in the other, 8–11 $\mu \times$ 10–18 μ, the germ pore extending nearly the entire length of spore; hyaline covering prominent when spores have been removed from the ascus. (*Pl. 3. f. 4–8.*)

Distinctive characters: Bristly hairs of perithecia and comparatively large flattened spores.

Cultivated specimens: On horse dung, New York City, N. Y., and Ft. Lee, N. J., summer, 1899; cow dung, Highmore, S. D.,

* This reference has not been seen, but a reprint of the original description occurs in Hedwigia, **12**: **131**. 1873.

Sept. 1899 (Carter); cow dung, Biloxi, Miss., Sept. 1899 (Tracy); cow dung, Kingston, R. I., Dec. 1899 (Underwood); cow dung, Rooks Co., Kan., August, 1899 (Bartholomew); Great Falls and Summit, Mont., August, 1900 (Griffiths & Lange).

12. SORDARIA LEUCOPLACA (B. & R.) E. & E. N. Am. Pyren. 127. 1892

Sphaeria leuçoplaca B. & R. Grevillea, **4**: 143. 1876.

Hypocopra leucoplaca (B. & R.) Sacc. Syll. Fung. **1**: 244. 1882.

Sordaria microspora P. & P. Grevillea, **6**: 28. *pl. 94, f. 3.* 1877.

Hypocopra microspora (P. & P.) Sacc. Syll. Fung. **1**: 241. 1882.

Perithecia scattered, superficial or sunken, 180–250 μ in diameter, membranaceous and often quite brittle, subglobose to pyriform, with usually a short papilliform or conical beak which, together with all exposed portions, is uniformly covered with short erect dark brown or black septate hairs or bristles.

Asci 8-spored, cylindrical, with a truncate perforate apex and a short contracted stipe, 60–120 $\mu \times$ 8–9 μ: paraphyses filiform, obscurely septate and a trifle longer than the asci.

Spores uniseriate, ellipsoid to subglobose, always rounded at the ends, often slightly flattened, 5–6 $\mu \times$ 6.5–9 μ; germinal pore extending along one side nearly the length of the spore; gelatinous envelope plainly visible only after the spores have been removed from the ascus. (*Pl. 3, f. 9–15.*)

Distinctive characters: Bristly perithecium and small size throughout.

Dry specimens: On cow dung, Ravenel, Fung. Car. Exsic. **4**: no. 61.

Cultivated specimens: On horse, cow and goat dung, New York City and Ft. Lee, N. J., summer, 1889; cow dung, Kingston, R. I., Dec. 1899 (Underwood); horse dung, Aberdeen, S. D., Sept. 1899 (Towne); cow dung, Highmore, S. D., Sept. 1899 (Carter); cow dung, Biloxi, Miss., Sept. 1899 (Tracy); burro dung, Hermosa, Colo., March, 1899 (Baker, communicated by Earle); horse dung, Auburn, Ala., Aug. 1899 (Earle); horse and cow dung, Summit, Mont., Aug. 1900 (Griffiths and Lange).

The occurrence and the characteristics of the two previous species are so intimately related that it seems best to discuss them together. As is readily seen from the descriptions given, the real difference is one of size. According to my interpretation, based on observation of the dry and cultivated material at hand, the variability of this character has led to the establishment of unwarranted species. Plowright, for instance, in commenting upon *S. microspora* and *S. platyspora*, states that they are closely related to *S. discospora*, but evidently different. Again Niessl, in Krieger's Fungi Saxonici, no. 166, says that he is perfectly familiar with *S. microspora*, but has always considered it to be a small-spored form of *S. discospora*. The two forms recognized here grow intimately mixed and it is seldom that one is found without the other, the larger spored one, *S. discospora*, being usually the less frequent. The specimen quoted above shows the same condition that one meets with in the American forms. Both large- and small-spored forms grow together. Several perithecia examined contained spores identical with the original *S. leucoplaca* while others agreed with *S. discospora*. Winter recognized a variety of *discospora* which he called *S. discospora major*. A specimen * of this at hand has spores larger than anything which has been seen from this country, and indeed the variety is larger throughout. It appears to me that there are three distinct forms in this group, the variety *major* and the two preceding species. After studying a great number of specimens in culture, I can readily conceive how Plowright could have concluded that the two species established by him might be "different from *S. discospora*." There certainly are forms which appear to be intermediate, but the difference between the extremes seems too great to permit uniting into one species.

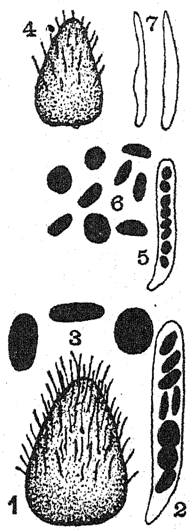

FIG. 3. After Plowright. 1–3, *Sordaria discospora*, perithecium, ascus and spores. 4–7, *Sordaria microspora*, perithecium, ascus, spores and paraphyses.

The "white floccose spot" on which the perithecium of *S. leu-*

* Krieger, Fung. Saxon. no. 74.

coplaca were said, in the original description, to be seated, does not appear in the specimens now, neither has such a characteristic been observed in any of my cultures. The frequency of asci with fewer than 8 spores is a very noticeable feature in the specimens cultivated. This is due to the abortion of one or more spores after they have been once formed. In the young stage one may find three or more olive-green spores and a corresponding number of abnormal hyaline ones in the same ascus. Later the hyaline spores entirely disappear. Dr. Plowright in response to a letter of inquiry concerning *Sordaria platyspora*, *S. microspora*, and *S. Californica*, states that he is unable to find the types of the first two named. Judging from the drawings and descriptions, however, there appears to be little room for doubt concerning them.

13. **Sordaria philocoproides** sp. nov.

Perithecia scattered, sunken, but becoming more or less superficial with age, subglobose, with small papilliform or indistinct beak, 300–400 μ in diameter, membranaceous, black and opaque, covered on all exposed portions with short stiff dark brown to black pointed continuous hairs.

Asci 32-spored, cylindrical to clavate, broadly rounded and simply perforate above, and contracted below into a short bluut stipe, 13–20 $\mu \times$ 90–110 μ: paraphyses filiform, septate, a little longer than the asci.

Spores in two to four series, slightly flattened, broadly ellipsoid to subcircular in one view and narrowly ellipsoid in the other, broadly rounded at the ends, 5.5–8 $\mu \times$ 8 μ; hyaline envelope rather indistinct and very narrow. (*Pl. 4, f. 17–19.*)

Distinctive characters: Polyspored asci, and bristle-like hairs of the perithecia.

Cultivated specimens: On rabbit dung, Ft. Lee, N. J., Jan. 1900.

This species is closely related to two others, *Sordaria polyspora* P. & P. and *S. Hanseni* Awd. It differs, however, from the former in having fewer spores in an ascus and larger spores with apices rounded instead of acute as figured in the original description.* The latter is described as having spores without gelatinous appendages or covering.

* Grevillea, 10: 73. *pl. 153. f. 1.* 1881.

II. PLEURAGE Fries, Summa Veg. Scand. **2**: 418. 1849.

Schizothecium Corda, Icones Fung. **2**: 29. 1835. Not *Schizotheca* Ehrenb. 1832.

Sordaria Fuckel, Symbol. Mycol. p. 244. 1869; Saccardo, Syll. Fung. **1**: 230. 1882, etc.

Podospora Cesati; Rabenh. Herb. Mycol. no. 259; Hedwigia, **1**: 103. 1852; Ellis & Everhart, N. Am. Pyren. 128. 1892. Rabenhorst, Krypt.-Flora, **1**^{2}: 169. 1887.

Malinvernia Rabenhorst, Hedwigia, **1**: 116. 1852.

Philocopra Speg. Anales Soc. Sci. Argent. 192. 1880; Ellis & Everhart, N. Am. Pyren. 132. 1892.

Perithecia scattered or aggregated, superficial or sunken, membranaceous or coriaceous, without stroma. Asci without functional internal membrane or apical perforation, stretching at maturity. Paraphyses ventricose or filiform-tubular, usually agglutinated and longer than the asci. Spores ellipsoid, with or without primary appendages, but always having attached to them at maturity two or more hyaline gelatinous secondary appendages of variable length.

Key to the Species

Asci 4-spored
- Perithecia smooth above substratum. — 1. *P. anomala*
- Perithecia hairy above the substratum.
  - Primary appendages of spores absent. — 2. *P. Arizonensis.*
  - Primary appendages of spores reduced to a small triangular apiculum. — 3. *P. taenioides.*
  - Primary appendages of spores elongated and cylindrical.
    - Hairs of perithecium long, dark brown, sparingly septate and arranged in tufts on convex side of curved beak. — 4. *P. anserina.*
    - Hairs of perithecium consisting of tufts of irregular fuscous cells. — 5. *P. tetraspora.*

Asci 8-spored.
- Primary spore appendages present.
  - Perithecia hairy above the substratum.
    - Hairs agglutinated and consisting of bunches of irregular cells.
      - Spores uniseriate. — 6. *P. minuta.*
      - Spores biseriate. — 7. *P. curvula.*
    - Hairs short, scattered and bristly.
      - Spores uniseriate. — 8. *P. minor.*
      - Spores biseriate.
        - Primary appendage cylindrical. — 9. *P. amphicornis.*
        - Primary appendage short, only ⅓–½ length of spore, and often triangular. — 10. *P. superior.*
        - Primary appendage pestle-shaped. — 11. *P. fimiseda.*

Hairs consisting of long flexuous mycelial strands which ramify over the substratum.
Beak absent. 12. *P. erostrata.*
Beak present.
Beak covered with hairs. 13. *P. Ellisiana.*
Beak naked, black.
Spores uniseriate. 14. *P. arachnoidea.*
Spores biseriate.
Spores consisting of a fertile cell at each end of a long hyaline filament. 15. *P. zygospora.*
Spores simple with usually four gelatinous appendages at each end. 16. *P. vestita.*
Hairs branched, roughened and forming a dense brown felt.
17. *P. Californica.*
Perithecia tubercular 18. *P. striata.*
Perithecia covered with white tomentum. 19. *P. albicans.*
Perithecia naked above the substratum.
Spores completely covered by secondary appendages.
20. *P. longicaudata.*
Spores with appendages confined to the ends. 21. *P. decipiens.*
Primary spore appendages absent.
Spores uniseriate.
Perithecia hairy. 22. *P. Kansensis.*
Perithecia smooth. 23. *P. brassicae.*
Spores biseriate. 24. *P. multicaudata.*
Asci more than 8-spored.
Perithecia hairy above the substratum.
Perithecia covered with tomentum of roughened hairs. 25. *P. lutea.*
Perithecia hairy but not tomentose and having no roughened hairs.
Primary spore appendages absent. 26. *P. heterochaeta.*
Primary spore appendages present.
Hairs short, tufts of irregular cells. 27. *P. Dakotensis.*
Hairs long and single.
Hairs straight and more or less clustered. 28. *P. curvicolla.*
Hairs flexuous and similar to the mycelium.
29. *P. collapsa.*
Perithecia naked above the substratum.
Secondary spore appendages prominent and easily distinguishable at maturity. 30. *P. pleiospora.*
Secondary spore appendages indistinct at maturity and very fugacious.
31. *P. adelura.*

1. **Pleurage anomala** sp. nov.

Perithecia half sunken or entirely superficial and imbedded in a dense growth of greenish or brownish mycelium which is attached to the perithecium especially around the center, membranaceous, black above and dark brown below, about $300 \times 500\,\mu$, pyriform with papilliform curved black beak.

Asci 4-spored, cylindrical, broadly rounded above, and tapering below into a slender stipe, 18–21 $\mu \times$ 165–190 μ: paraphyses agglutinated, ventricose, longer than the asci.

Spores uniseriate, ellipsoid to subglobose, rounded above and broadly rounded to truncate below, 13–16 $\mu \times$ 18–21 μ, dark brown in color; primary appendage nearly equalling the spore in length, cylindrical, straight or slightly curved, tipped as is also the apex of the spore with long lash-like gelatinous secondary appendages of variable length. (*Pl. 5. f. 7–9.*)

Distinctive characters: Dense growth of mycelium and 4-spored asci.

Cultivated specimen: On cow dung in Columbia greenhouse, New York City, spring and summer, 1899.

In the old state the species resembles *P. coprophila* very closely for then the hairiness of this species and the tomentum of the other disappear. But even then they can be separated readily by the characteristics of the asci and spores. It has not been met with except in the one locality mentioned above, but several collections of it were made here. The substratum had been used as a mulching for a species of palm and had remained in the greenhouse since the previous autumn.

2. **Pleurage Arizonensis** sp. nov.

Perithecia scattered or aggregated in small groups, at first sunken, but becoming half exposed at maturity, 400–600 μ in diameter, membranaceous to slightly coriaceous, black and opaque, globular to pyriform, the exposed portion covered with a white tomentum up to the short cylindrical or papilliform black and curved beak, the convex side of which is ornamented with several tufts of long brown hairs.

Asci 4-spored, cylindrical, slightly contracted and rounded at the apex, and tapering below into a long slender crooked stipe, 38–45 $\mu \times$ 240–325 μ: paraphyses variable, usually broadly filiform, tapering upward, much longer than the asci, the outer ones decidedly ventricose and somewhat agglutinated.

Spores vertically uniseriate, ellipsoid, inequilateral or slightly flattened on one side, broadly rounded at the ends, 21–25 $\mu \times$ 45–52 μ, ranging from hyaline when young through olivaceous to dark brown and opaque; primary appendages entirely absent, but both upper and lower ends of the spore are tipped with long, lash-like, gelatinous, eccentrically attached appendages which are marked longitudinally with a furrow which shows them to be made up of two closely united filaments. (*Pl. 6. f. 4–6.*)

Distinctive characters: White tomentum, setae of perithecia, and entire absence of primary appendages.

Cultivated specimens: On sheep and cow dung, Tucson, Ariz., Jan. 1900 (Tyler); cow dung, Mesilla Park, N. M., Jan. 1900 (Wooton).

A very characteristic species which is easily distinguished from *P. taenioides*, to which it is most closely related, by the characters given above. In age and in the presence of an excessive amount of moisture the white tomentum disappears and the exposed portion of the perithecium becomes black and bare, with the exception of the convex portion of the beak which bears the tufts of setae.

3. **Pleurage taenioides** sp. nov.

Perithecia scattered, half sunken, or occasionally aggregated in small clusters and erumpent between the fibers of the substratum, about .5 mm. × .75 mm., slightly olivaceous when young, but becoming black, opaque and slightly coriaceous at maturity, covered uniformly, on all exposed portions by short straight septate brown hyaline-tipped fugaceous hairs, globular to pyriform with a long cylindrical curved or twisted beak.

Asci 4-spored, cylindrical, broadly rounded above and contracted below into a long slender crooked stipe, persistent, 37–45 μ × 290–360 μ: paraphyses filiform to tubular or even slightly ventricose below, tapering upward, septate, longer than the asci.

Spores uniseriate, ellipsoid to oval, broadly rounded at the ends, ranging in color from hyaline when young through olivaceous to dark brown and opaque, 29–32 μ × 56–62 μ: primary appendage reduced to a minute hyaline or often slightly colored apiculum at lower end of the spore, the secondary lower appendages gelatinous, very long, attached apically to spore and inclosing the minute apiculum; easily resolved into two closely united portions which appear to lose their individuality distally, more or less of the length being thrown into convolutions resembling segments of the tapeworm; upper appendage slightly smaller than the lower and eccentrically attached. (*Pl. 6. f. 1–3.*)

Distinctive characters: Large spores, minute apiculum and long convoluted appendages.

Cultivated specimens: On horse and cow dung, New York City, Aug. 1899; cow dung, Little Ferry, N. J., Sept. 1899; horse dung, Schaghticoke, N. Y., Aug. 1899 (Banker); horse dung, Mesilla Park, N. M., Jan. 1900 (Wooton); horse dung,

Emma, Mo., Aug. 1899 (Demeterio); cow, rabbit, and burro dung, Tucson, Ariz., Jan. 1900 (Tyler); horse, cow, dog, and rabbit dung, Austin, Texas, Jan. 1900 (Long); cow, sheep, and horse dung, Brookings, S. D., Nov. 1899 (Carter); rabbit and horse dung, Biloxi, Miss., Sept. 1899 (Tracy); horse, cow, and rabbit dung, Auburn, Ala., Aug. 1899 (Earle); cow dung, Kingston, R. I., Nov. 1899 (Underwood); horse and cow dung, Tucson, Ariz., Sept. 1900.

This is a common and distinctive species which in some respects closely resembles *P. hirta* Hansen and *P. australis* Speg. It may be distinguished from the former by somewhat larger spores, hyaline apicula and longer convoluted gelatinous appendages, and from the latter by having the spores in one series and by the apicula.

The principal variation observed in the comparison of specimens from different localities, pertains to the hairiness of the perithecia and the characteristics of the gelatinous appendages. The Texas specimens had almost smooth perithecia, and those on horse dung were completely sunken with only the beak projecting. In all other respects the specimens did not differ from the others. The convolutions of the gelatinous appendages are not always visible, owing to the immaturity of the spores. The best way to distinguish them is to examine the specimens at the time that the spores are being erupted from the asci. As the asci enlarge the appendages enlarge also, and the cross striations become more readily seen. They can, however, be distinguished in a nearly mature ascus before enlargement begins.

4. PLEURAGE ANSERINA (Rabh.) Kuntze, Rev. Gen. Plant. **3**^{3}: 504. 1898

Malinvernia anserina Rabenh. Herb. Mycol. no. 526.* Hedwigia, **1**: 116. *pl. 15. fig. 4.* 1857.

Sordaria anserina (Rabenh.) Wint. Abhand. naturforsch. Gesell. zu Halle, **13**: 100. *pl. 11. f. 20.* 1873. Zeitschrift gesammt. Naturwissen. (Halle), **56**: 541. 1883. Saccardo, Syll. Fung. **1**: 238. 1882. Natur. For. i Kjoben. Vidensk. Middel. for Aarene, 321, 353. *pl. 8. f. 21.* 1876.

Sordaria penicillata E. & E. Jour. Mycol., **4**: 78 (by error 66). 1888.

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* Specimen not seen.

Podospora penicillata (E. & E.) E. & E. N. Am. Pyren. 131. 1892.

Podospora anserina (Rabenh.) Rehm; Rabenhorst Kryptogamen-Flora, 1^2: 173. 1887.

Perithecia usually half sunken but often entirely superficial, scattered uniformly or aggregated in clusters of 2 to 6, 300–350 μ × 400–500 μ, pyriform, black above and greenish below, thin and membranaceous but not transparent; beak papillifom or slightly cylindrical, usually curved and bearing several tufts of long dark brown very sparingly septate hairs on the convex surface. Asci 4-spored, cylindrical, slightly contracted and rounded above, and contracted below into a long slender crooked stipe, quite persistent, 17–22 μ × 200–400 μ: paraphyses filiform or slightly ventricose below, decreasing in diameter upward, 1 ½–2 times the length of the ascus.

Spores uniseriate, elliptical, ranging from hyaline when young through olivaceous to dark brown and opaque, 18–20 μ × 34–42 μ, terminated below by a short hyaline primary appendage 1–1 ½ times the length of spore, this as well as the apex of the spore is terminated by a long lash-like gelatinous appendage of variable length, which by proper illumination can be resolved into two closely united strands which gradually merge into one another distally. (*Pl. 5, f. 4–6.*)

Distinctive characters: Dorsal tufts of long hairs and 4-spored ascus.

Dried specimens: On old pasteboard, Newfield, N. J., Aug. 1894 (Ellis); Chinese mats, St. Martinville, La., July, 1888 (Langlois); sheep dung, Lafayette, Ind., Feb. 1896 (Arthur).

Cultivated specimens: On cow and horse dung, Englewood, N. J., Sept. 1899; cow dung, Ft. Lee, N. J., July, 1899; horse dung, New York City, Aug. 1899; cow and horse dung, Aberdeen, S. D., Sept. 1899 (Towne); horse dung, Highmore, S. D., July, 1899 (Carter); cow dung, Doland, S. D., July, 1899 (Carter); horse, cow and sheep dung, Brookings, S. D., Nov. 1899 (Carter); rabbit dung, Mesilla Park, N. M., Jan. 1900 (Wooton); rabbit, dog, sheep and cow dung, Tucson, Ariz., Jan. 1900 (Tyler); horse dung, Emma, Mo., Sept. 1899 (Demetrio); cow dung, De Soto, La., Aug. 1899 (Frierson); cow dung, London, Canada, Aug. 1899 (Dearness); cow dung, Newfield, N. J., Aug. 1899 (Ellis); dog, horse, and cow dung, Austin, Tex., Jan. 1900 (Long); horse dung, Gunnison, Colo., Aug. 1899 (Bartholomew); horse

and cow dung, Proctor, Vt., Aug. 1899 (Banker); cow dung, Rooks Co., Kan., July, 1899 (Bartholomew).

Although this species is described in our literature with simple gelatinous appendages, there is no question but the European as well as the American forms have these appendages double. This feature is not always easy to determine in dried specimens but it can always be readily determined in fresh material when the spores are first released from the asci. All of the Italian * exsiccati at hand show unmistakable evidences of this characteristic even in the dry state. The hairiness of the beak of the perithecium is a characteristic of considerable variation. Some of the Missouri and Highmore, S. D., specimens show only a very few, short, scattered hairs, while others from other localities show all gradations between these forms and the typical ones. Careful examination of New York material has revealed the fact that these hairs are rather later in their development than similar structures in other species. Often one may find perithecia containing spores which are apparently mature with only very young imperfectly formed hairs on them. Later these develop into the normal condition. It would appear that the maturity of the spores can not be determined by the arbitrary characteristic of coloration, for they are not ejected from the ascus in this species until the external ornamentation of the perithecium has become mature. In other species, on the contrary, the spores are discharged as soon as they assume the brown coloration, and the asci will stretch in water even while the spores are greenish in color.

The mycelium of this species develops very rapidly in all directions from the germinating spores. In several cultures the perithecia developed on paper at a distance of 2–6.5 cm. from the substratum containing the spores. Indeed, in nearly every culture made, the perithecia developed on the paper which was placed under the dung, to a greater or less extent. The species appears to be suited to a paper medium as well as the *Chaetomiaceae* or *Sordaria fimicola*. As shown above, the species has often been collected on paper and similar substrata in nature.

* Saccardo, Mycotheca Veneta nos. 1178 and 1179; Cavara, Fungi Longobardiae exsic. no. 226.

5. Pleurage tetraspora (Wint.)

Sordaria tetraspora Wint. Hedwigia, **9**: 161. 1871; Zeitschrift gesammt. Naturwissen. *pl. 6. f. 1.* 1883; Griffiths, Bull. Torr. Club, **26**: 435. *pl. 1. f. 10–12.* 1899.

Perithecia superficial, pyriform to conical, scattered, thin, membranaceous, colorless to fuscous and so transparent that the spore-bearing arĕa which occupies rather less than half the length of the perithecium can be readily distinguished by transmitted light, covered with short septate agglutinated hairs which are more prominent around the smooth black naked erect or curved beak, 140–180 $\mu \times$ 360–510 μ.

Asci 4-spored, cylindrical, rounded above and contracted below into a stipe one-half the length of the spore-bearing portion, 15–18 $\mu \times$ 100–110 μ: paraphyses ventricose, longer than the asci, but not much mixed with them.

Spores uniseriate, elliptical, broadly but acutely rounded, olivaceous to black and opaque when mature, 13–14 $\mu \times$ 16–22 μ; primary appendage short, straight or slightly curved and very fugacious; both primary appendage and apex of spore tipped with long lash-like, gelatinous secondary appendages which are made up of two or more filaments closely united.

Distinctive characters: Agglutinated hairs, 4-spored asci, and small size.

Cultivated specimens: On dead culms of *Poa Nevadensis*, Big Horn Mountains, near Buffalo, Wyo., Aug. 1898 (Williams & Griffiths); horse dung, Summit Mont., Aug. 1900 (Griffiths & Lange).

This species was established by Dr. Winter * upon a single perithecium collected in Saxony in 1871. Two years later, in 1873, when he published his monograph † of the German species, he remarked that he was hasty in his judgment in his former paper and reduced the above name to a synonym, at the same time remarking that as the 4-spored characteristic appears constant it might be well to retain the name, *tetraspora,* for the variety. Later he found many specimens of the 4-spored form in his own collections; but from Dr. Lange and Herr Fuckel he received specimens which contained the 8-spored form as well. The specimen from Fuckel was accompanied by a diagnosis and

* Hedwigia, **9**: 161. 1871.

† Abhand. naturforsch. Gesell. zu Halle, **13**: 100. 1872.

the name, *Sordaria minuta.* Winter accepts this name for the species, although it was not published until 1873.‡ According to our modern rules, Winter's name would hold for the species; but it seems better at present to consider both forms distinct, thereby retaining both names. In all the material examined during the past two years only two specimens contained the 4-spored form. In all the other specimens where hundreds of perithecia were examined, for the express purpose of finding this form, not even a single ascus was observed to contain but four spores.

In order to push the determination still further, the small quantity of the Wyoming material on hand was planted on a sterilized substratum of horse dung after it had remained in the laboratory in a dry state for about one year. In approximately four weeks mature perithecia were found in considerable numbers, and all contained 4-spored asci. The infrequency of this form, together with the constancy of this characteristic, appear to me to warrant its treatment as a distinct species. The fact that Winter found the two forms growing together argues but little, for one may often find any two or more of the species of this family growing with their perithecia completely intermingled. If both forms of asci were found in the same perithecium the question would be settled; but there is no record of this ever having been done.

6. PLEURAGE MINUTA (Fuckel) Kuntze Rev. Gen. Plant. **3**^{2}: 505. 1898

Sordaria minuta Fuckel, Symbol. Mycol. appendix 2: 44. 1873. Abhand. naturforsch. Gesell. zu Halle, **13**: 100–101. *pl. 11. f. 21.* 1873. Schenk's Handbuch der Bot. **4**: 358, 725. *f. 58, 60.* 1890. Zeitschrift gesammt. Naturwissen. **56**: *pl. 6. f. 1.* 1883. Cohn's Krypt.-Flora Schlesien, **3**^{2}: 286. 1894. Saccardo Syll. Fung. **1**: 231. 1882.

Podospora minuta (Fuckel) Rehm; Rabenhorst, Kryptogamen-Flora, **1**^{2}: 174. 1887.

Perithecia superficial or with base slightly sunken in the substratum, scattered, 225–300 $\mu \times$ 375–525 μ, thin, membranaceous, transparent, covered with bunches of septate, agglutinated hairs which stand erect when young, but become recurved with age, pyriform to conical, colorless to fuscous, beak short, papilliform, black, with the ostiolum plainly visible.

‡ Symbol. Mycol. append. 2: 44.

Asci 8-spored, cylindrical, evanescent, rounded above and contracted below into a short stipe, $16–19\mu \times 130–160\mu$: paraphyses ventricose, slightly longer than asci and not much mixed with them.

Spores uniseriate, elliptical, broadly but acutely rounded, ranging from hyaline when young through olivaceous to dark brown and opaque, $13–14\mu \times 15–20\mu$; primary appendage cylindrical, straight or curved fugaceous and shorter than the spore, both this and the apex of the spore tipped with a long lash-like gelatinous filament which on close examination is seen to be made up of two united smaller ones. (*Pl. 7. f. 7–10.*)

Distinctive characters: The peculiar agglutinated hairs, uniseriate spores and small size.

Cultivated specimens: On horse dung, New York City, Nov. 1899; goat dung, Ft. Lee, N. J., Nov. 1899; cow dung, Rooks Co., Kan., July, 1899 (Bartholomew); sheep dung, Kingston, R. I., Dec. 1899 (Underwood); cow, rabbit, and burro dung, Tucson, Ariz., Jan. 1900 (Tyler); burro dung, Hermosa, Col., March, 1898 (Baker, communicated by Earle); sheep and cow dung, Brookings, S. D., Sept. 1899 (Carter); horse dung, Auburn, Ala., Aug. 1899 (Earle); sheep dung, Meridian, N. Y., Aug. 1899 (Banker); horse dung, Austin, Texas, Jan. 1900 (Long).

The Colorado specimens differed from all others examined in having slightly wider spores and almost naked perithecia. The texture, habitat, color and appendages were, however, so characteristic that these variations are considered simply individual peculiarities which correspond to similar ones found in the nearly related species, *P. curvula*. The tufts of hairs so characteristic of these species are very similar in both of them. There is really less difference between the hairiness of *P. minuta* and some forms of *P. curvula* than between the varieties included under the latter. Occasionally also the spores of this species become biseriate by the uncoiling and untwisting of the appendages in rupturing the perithecia. But this disturbed arrangement is always readily distinguished from the true biserial condition of the spores of *P. curvula*. Winter expresses a question as to whether this species s really distinct from *P. curvula*. They have been grown side by side on filter paper as well as on the natural substratum and there appears to be no question but that there are constant differences

especially in the size of the perithecia and asci. They may often be found growing together, however; and under such circumstances the similarity of the perithecia, in everything but size, would rather lead one to decide in favor of Winter's suggestion. But the fact that Winter did not himself follow this suggestion leads us to give it but little weight, especially when considered in connection with evidence to the contrary, although that evidence is mainly one of size. (See also under *P. tetraspora.*)

7. PLEURAGE CURVULA (DeBary) Kuntze, Rev. Gen. Plant. 3^2: 505. 1898

Sordaria curvula DeBary, Morphol. und Physiol. Pilze, **1**: 209. 1866.* Abhand. naturforsch. Gesell. zu Halle, **13**: 101–103. *pl. 11. f. 22.* 1873. Zeitschrift Naturwissen. (Halle), **56**: 539–574. *pl. 6. f. 2–9.* 1883. Cohn, Krypt.-Flora Schlesien, 3^2: 286. 1894. Schenk, Handbuch der Bot. **4**: 358. *f. 60.* 1890. Saccardo, Syll. Fung. **1**: 233. 1882.

Podospora curvula (DeBary) Rehm; Rabenhorst Krypt.-Flora, 1^2: 174–175. 1887. Ellis & Everhart, North American Pyrenomycetes, 129. 1892.

Ixodiopsis fimicola Karst. Acta Soc. pro fauna et flora Fennica, **2**: 78. 1881.

Cercophora conica Fuckel, Symb. Mycol. 245. 1869.

Perithecia scattered, with base slightly sunken or irrumpent in clusters between the fibers of the substratum, about 375 $\mu \times$ 600 μ, thin membranaceous, transparent, hyaline to fuscous, all of the exposed portion more or less covered with bunches of agglutinated obliquely septate constricted hairs which are more or less prominent around the beak, but diminish in size and prominence downward until they become simple papillae, pyriform conical with short, black, papilliform beak containing a prominent ostiolum.

Asci 8-spored, clavate contracted above, and tapering below into a moderately long slender stipe, 22–28 $\mu \times$ 150–180 μ, evanescent: paraphyses ventricose, agglutinated, longer than the asci and not much mixed with them.

Spores biseriate, ellipsoid to slightly ovate, ranging from hyaline when young through olivaceous to dark brown and opaque, 13–16 $\mu \times$ 21–25 μ; primary appendage ½–⅔ the length of the spore, cylindrical, straight or curved; this as well as the apex of

* This edition of DeBary is not at hand.

the spore tipped with long, lash-like, gelatinous secondary appendages, varying in length with the stage of development, the upper being excentrically placed and both being made up of two closely united filaments which are plainly distinguishable proximally but which appear to gradually fuse together distally. (*Pl. 7. f. 1–6.*)

Distinctive characters: Agglutinated hairs of perithecium and biseriate arrangement of spores.

Dry specimens: On cow dung, Newfield, N. J., Oct. 1893 (Ellis).

Cultivated specimens: On horse, cow and goat dung, New York City, summer and autumn, 1899; cow and horse dung, Ft. Lee and Englewood, N. J., autumn, 1899; cow dung, Schaghticoke, N. Y., Aug. 1899 (Banker); horse, sheep and cow dung, Tucson, Ariz., Jan. 1900 (Tyler); cow dung, Rooks Co., Kan., July 1899 (Bartholomew); horse dung, Aberdeen, S. D., Sept. 1899 (Towne); horse dung, Aberdeen, S. D., Oct. 1895; horse, cow, sheep and pig dung, Brookings, S. D., Nov. 1899 (Carter); horse dung, Austin, Texas, Jan. 1900 (Long); horse dung, Auburn, Ala., July 1899 (Earle); horse dung, Gunnison, Colo., Aug. 1899 (Bartholomew); cow dung, Great Falls, Mont., Aug. 1900; rabbit dung, Lincoln Co., N. M., Aug. 1900 (Earle).

With reference to the name of this species the reader is referred to p. 40. It should be stated here that *Schizothecium fimicolum* Corda,* in my opinion, is this species, but others have considered it to be *Podospora fimicola* † Cesati. There is now no possibility of determining with any degree of certainty what plant Cesati had. It therefore seems wise to retain the name of DeBary rather than go back to one which is of uncertain identification. Corda's figures might refer to any one of the species which have agglutinated hairs. The only feature found in his drawings, upon which one is able to form an opinion as to species, is the tufts of hair which he represents in a vertical section of the perithecium. Again, if he had any one of these species, it is very strange that he should not have found the asci, for only in very exceptional cases are they totally absent, even in dry specimens.

The species is very variable in its external aspect. On this account several varieties have been named, based mainly on hairi-

* Icones Fungorum, 2: 29. *pl. 13. f. 105.* 1835.

† Hedwigia, 1: 103. *pl. 14. f. A, 1–11.* 1856.

ness of the perithecium; and two of these are recognized by Rehm,* *P. curvula coronata* and *P. curvula aloides*.

The typical form of *Pleurage curvula aloides* has been met with from a single locality in the vicinity of New York City. All gradations of hairiness occur from small tufts scarcely larger than those of *P. minuta* to the prominent tufts represented in *pl. 7. f. 2–3*.

8. **Pleurage minor** (E. & E.)

Podospora minor E. & E. Am. Nat. **31**: 341. 1897.

Sordaria minor (E. & E.) S. & S. Syll. Fung. **14**: 493. 1899.

Perithecia scattered or loosely aggregated, erumpent with simply the base sunken at maturity, pyriform to conical and clothed on all exposed portions except the black papilliform to conical beak with short sparingly septate crooked brown hairs, about 400 μ × 500–600 μ thick, coriaceous, black and opaque.

Asci 3–8-spored, cylindrical, rounded above and contracted below into a short blunt stipitate base, evanescent, 20–24 μ × 170–190 μ: paraphyses filiform above but slightly ventricose below, longer than the asci and not much mixed with them.

Spores obliquely uniseriate, ellipsoid to ovate and irregular in outline: 18–24 μ × 30–45 μ: primary appendage short cylindrical or clavate, straight or curved, hyaline to brown; secondary appendages long, lash-like and attached to the extremity of the primary and to the apex of the spore, the upper one being the larger and often tinted with brown. (*Pl. 7. f. 14–16.*)

Distinctive characters: Perithecial hairs and short primary appendages of the spores.

Dry specimen: On old corn stalks, Rooks Co., Kan., July, 1896 (Bartholomew).

This type was kindly loaned to me by the collector. Like some other species of this family the number of spores in the ascus appears to vary on account of abortion of one or more of the typical number, eight. The ascus illustrated in the accompanying figure has but seven spores with no signs of the eighth. This is often the case in mature asci but in the younger ones one or more hyaline abortive spores may be found mixed with the olive-green to light brown ones. This is not due to an inequality in the time of maturity as is the case in some Ascomycetes.

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* Rabenhorst, Krypt.-Flora, 1^2: 174–175. 1887.

9. PLEURAGE AMPHICORNIS (Ellis) Kuntze, Rev. Gen. Plant. 3^3: 505. 1898

Sphaeria (*Sordaria*) *amphicornis* Ell. Bull. Torr. Club, **6**: 109. 1876.

Sphaeria eximia Peck, Reg. Rep. **28**: 78. *pl. 2. f. 14–18.* 1875.

Podospora amphicornis (Ell.) E. & E. N. Am. Pyren. 130. 1892.

Sordaria amphicornis Ell. Sacc. Syll. Fung. **1**: 235. 1882.

Perithecia scattered, superficial or with base slightly sunken, 350–400 μ × 450–600 μ, membranaceous to coriaceous, black and covered sparingly with short, straight septate brown hairs, ovate to ovate-conical with short flat papilliform black ostiolum.

Asci 8-spored, clavate, contracted and rounded above, and tapering below in a short stipitate base, 32–35 μ × 185–225 μ. The characteristics of the paraphyses can not be determined from the dried specimens at hand.

Spores biseriate, ellipsoid, somewhat sharply rounded at the ends, 14–18 μ × 24–32 μ, dark brown and opaque when mature; primary appendage cylindrical, straight, about one-third to two-third as long as spore; secondary appendages long, lash-like, gelatinous, attached to apex of spore and tip of primary appendage, composed of two closely united filaments which become indistinguishable distally. (*Pl. 7. f. 11–13.*)

Distinctive characters: Hairy superficial perithecium with small papilliform beak.

Dry specimens: On rabbit dung, Kosoag, New York, July 1874; rabbit dung, Newfield, N. J., Aug. 1885 (Ellis); Bruse Peninsula, Canada, Aug. 1898 (Dearness).

Regarding the synonomy of this species, see Ellis & Everhart, North American Pyren. 130, note.

10. **Pleurage superior** sp. nov.

Perithecia superficial, scattered, thin, membranaceous, brown and somewhat transparent to black and opaque in age, pyriform with short papilliform curved or erect beak, about 450 × 600 μ; the whole perithecium covered with short blunt septate brown hyaline-tipped bristle-like hairs which are uniformly distributed over the entire surface with the exception of a small area around the ostiolum.

Asci 8-spored, clavate, contracted and rounded above and tapering below into a long rather slender crooked stipe, 250–275 × 30–40 μ, evanescent: paraphyses somewhat ventricose,

tapering upward and becoming filiform above, not mixed with the asci but much longer.

Spores biseriate, elliptical, narrowly rounded to subacute above and broadly rounded to truncate below, 12–14 $\mu \times$ 23–27 μ, ranging from hyaline when young through olivaceous to dark-brown and opaque; primary appendage short, tapering downward and often triangular in outline in optical section, one-third to one-half the length of the spore; secondary appendages at either end of spore, long, lash-like and evidently made up of two components which are plainly separated proximally but which may appear merged distinctly, usually the two parts of the lower one when freed separate widely or become twisted about each other. (*Pl. 19. f. 14–16.*)

Distinctive characters: Small bristly superficial perithecia.

Cultivated specimen: On cow dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

10. **Pleurage fimiseda** (Ces. & DeNot.)

Podospora funicola Ces.; Rabenhorst Herb. Mycol. ed. nov. no. 259; Hedwigia, **1**: 103. *pl. 14. f. A.* 1856.

Sordaria fimiseda Ces. & DeNot. Comment. della Soc. Crittogam. Italiana, **1**: 226. 1863; Abhand. naturforsch. Gesell. zu Halle, **13**: 80. *pl. 9. f. 13.* 1873; Natürlichen Pflanzenfamilien, **1**^{1}: 191. *f. 253, A–D.* 1897; Cohn's Kryptogamen-Flora Schlesien, **3**^{2}: 288. 1894; Mem. R. Acad. Sci. di Torino **1**: 22. *f. 19.* 1863; Abhand. Senkenberg. naturforsch. Gesell. (Frankfort), **7**: 332–346. *pl. 2–4.* 1869.

Podospora fimiseda (Ces. & DeNot.) Rehm; Rabenhorst Kryptogamen-Flora, **1**^{2}: 170; N. Am. Pyren. 130. 1892.

Cercophora fimiseda Fuckel, Symb. Mycol. 244. *pl. 4. f. 1.* 1869.

Pleurage fimicola Kuntze, Rev. Gen. Plant. **3**^{3}: 504. 1898.

Perithecia pyriform, large, superficial, scattered or aggregated in small clusters and erumpent between the undigested fibers of the substratum; about 1 mm. in its greatest diameter, densely covered on all the exposed portions by short straight septate brown hairs, which have hyaline tips when young and, therefore, give the perithecium a grayish appearance, greenish when young, but becoming black and opaque with age; walls of the perithecium thick and coriaceous in texture.

Asci 8-spored, clavate, contracted and rounded above, and

tapering below into a long stipe, evanescent, $55–65\,\mu \times 330–375\,\mu$: paraphyses abundant, filiform or slightly ventricose below, tapering upward, much longer than the asci.

Spores biseriate, 4 and 4 or 2 and 6, ellipsoid, $27–32\,\mu \times 53–60\,\mu$, ranging from hyaline when young through olivaceous to dark brown and opaque; primary appendage clavate and slightly shorter than the spore; secondary appendages very long and attached to distal end of the primary and excentrically to the apex of the spore, the upper one larger than the lower, and each made up of two distinct parts closely united, and each of these in turn showing longitudinal striations which indicate still finer subdivisions. (*Pl. 8. f. 1–5.*)

Distinctive characters: Hairiness of the perithecium and long peculiar spore appendages.

Cultivated specimens: On horse dung, New York City, July 1899; cow dung, Ft. Lee, N. J., Oct. 1899; horse dung, Fairfield, N. Y., Aug. 1899 (Banker); horse and cow dung, Schaghticoke and Baldwinsville, N. Y., Aug. 1899 (Banker); horse dung, London, Canada, Aug. 1899 (Dearness); horse dung, Brookings, S. D., Nov. 1899 (Carter); horse dung, Aberdeen, S. D., Sept. 1899 (Towne).

Otto Kuntze in his late work adopts the name quoted above, under the impression that *Schizothecium fimicolum* Corda = *Podospora fimicola* Ces. He must however have done this in entire ignorance of either the figures of Corda or Cesati. As stated elsewhere it is impossible to determine exactly what species Corda had, but a mere glance at his figures will convince one that he had one of the species with agglutinated hairs and appendaged spores. Both of these species belong to the genus *Pleurage*, but they are not the same plant by any means. It is true that some authors have referred the two to the same species doubtfully, but Rehm refers Corda's species questionably to *P. curvula* DeBary. Rehm is more nearly correct than the other authors, but it can not be determined with certainty. We are thus left the alternative of adopting Cesati's homonym or the name given later by Cesati and De Notaris. The latter, of course, appears the better plan. This leaves *Schizothecium fimicolum* Corda an undetermined and indeterminable species, but one without doubt belonging to the genus *Pleurage*, as the type of that genus.

The species is of much interest for several reasons. Much of

our knowledge of the group is based on Woronin's * investigations of this species. It is one of the largest plants of the genus and one of only two or three in the whole family in which conidia have been actually found. It is also one of the few species of the family that have thick leathery perithecia. Woronin distinguishes three distinct layers of tissue aggregating about ten cells in thickness.

Dry specimens behave rather peculiarly when soaked in water or caustic potash preparatory to mounting. After remaining in the water for an hour or longer, the outside tissue of the perithecium swells to a considerable extent, and may be removed by gentle agitation of water or by dissection with needles, without interfering with the inner layers or their contents in the least. (See also under *Sordaria bombardioides*.)

12. **Pleurage erostrata** sp. nov.

Perithecia scattered and entirely superficial, 180–225 μ in diameter, thin membranaceous, ranging from hyaline when young through greenish to black and opaque, completely covered with long flexuous septate brown hairs, spherical, with no beak and apparently no ostiolum.

Asci 8-spored, clavate, rounded above and contracted below into a short stipitate base, very evanescent, 16–21 $\mu \times$ 48–54 μ: paraphyses absent.

Spores biseriate, ellipsoid to ovate, acutely rounded above and broadly rounded to truncate below, ranging from hyaline when young through olivaceous to dark brown and opaque, 6.5–8 μ $\times$ 11–13 μ; primary appendage rather shorter than the spore, cylindrical, straight, both this and the apex of the spore tipped with short very evanescent gelatinous awl-shaped appendages. (*Pl. 4. f. 11–13.*)

Distinctive character: Globular hairy perithecia.

Cultivated specimens: On horse dung, Aberdeen, S. D., Oct. 1895; horse, cow, and rabbit dung, Tucson, Ariz., Jan. 1900 (Tyler); cow dung, Rooks Co., Kan., July 1899 (Bartholomew); cow and sheep dung, Austin, Texas, Jan. 1900 (Long); horse dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

It will be seen from the description of the perithecium given above that this species in some particulars resembles the *Perispo-*

* Abhand. Senckenberg. Gesell. (Frankfort) 1869.

riales. Very careful studies have been made of the perithecia to determine whether there was not really a functional ostiolum, although none was visible; but no evidences were found of any difference in the thickness of the perithecium wall at the point where we would expect the opening to be found. This character, according to the distinctions of the group, would place this immediately in the *Perisporiales.* But when the spores are examined and their development traced one cannot but conclude that the species has very decided relationships to the genus *Pleurage.*

Abundance of material has been obtained from the several localities. That from Aberdeen produced perithecia comparatively few and scattering, and the mycelium was not abundant enough to attract much attention. The Tucson specimens, however, produced a thick feltwork of mycelium over large areas of the substratum, and the perithecia were so numerous as to give their characteristic color to the entire culture; indeed the growth was so vigorous as to choke out almost everything else. The mycelium is not that produced from the spore, but simply the perithecial appendages. The Texas specimens had much the same characteristics of growth as those from Arizona. The age of the Aberdeen material may have had something to do with the apparent lack of vigor.

13. **Pleurage Ellisiana** sp. nov.

Perithecia scattered, half-sunken or superficial and imbedded in a dense growth of brown mycelium, about $300\,\mu \times 500\,\mu$, thin membranaceous, olivaceous below and brown above, pyriform, with papilliform black curved beak which is uniformly and sparingly covered with short straight sparingly septate hairs.

Asci 8-spored, clavate, contracted and rounded above and tapering below into a long slender stipe, evanescent, $26–32\,\mu \times$, $160–185\,\mu$: paraphyses filiform, septate, slightly constricted below, longer than the asci.

Spores biseriate, ovate to broadly ellipsoid, ranging from hyaline when young through olivaceous to dark brown and opaque, $11–16\,\mu \times 21–27\,\mu$: primary appendages one-half to once the length of the spore, cylindrical, straight, both this and the apex of the spore tipped with long lash-like gelatinous appendages, the upper one being eccentrically attached. (*Pl. 5. f. 1–3.*)

Distinctive characters: Abundant development of mycelium, the hairy beak, and the spore characteristics.

Cultivated specimens: On cow dung, Englewood, N. J., Aug. 1899; cow dung, Newfield, N. J., Aug. 1899 (Ellis).

The spores and asci of this species resemble those of *P. curvula* somewhat, but it is readily distinguished from this species by the external characteristics of the perithecium. Two collections of this species were made near Englewood during the month of August; but in each case the perithecia were few and scattering, as were also those obtained from the Newfield cultures.

14. **Pleurage arachnoidea** (Niessl.)

Podospora arachnoidea Niessl.; Krieger, Fung. Saxonici exsic., no. 371; Hedwigia, **35**: (143). 1896.

Sordaria arachnoidea (Niessl.) S. & S., Syll. Fung. **14**: 492. 1899.

Perithecia scattered, partially sunken or superficial and imbedded in a dense growth of mycelium, about 375 $\mu \times 525$ μ, mem-

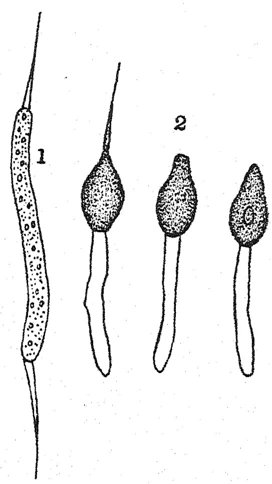

FIG. 4. *Pleurage arachnoidea* after Niessl. 1, young spore; 2, mature spores.

branaceous to slightly coriaceous, dark brown to black and opaque, densely covered with long septate brown hairs on all exposed portions, pyriform with a bare black papilliform curved beak.

Asci 8-spored, cylindrical, rounded above and tapering below into a long slender stipe, 18–21 $\mu \times$ 180–250 μ, apex of ascus containing a large shining highly refractory granule which becomes visible before the spores: paraphyses filiform, septate, slightly constricted, longer than the asci.

Spores uniseriate, irregular and variable in outline, generally ellipsoid to oval, 6–11 $\mu \times$ 17–21 μ, ranging from hyaline when young through olivaceous to dark brown and opaque; primary appendages very long, curved and overlapping the spore below, this as well as apex of the spore tipped with rather short gelatinous lash-like secondary appendages. (*Pl. 5. f. 14–20.*)

Distinctive characters: Long cylindrical asci, long cylindrical curved appendages of spores, and the hairy perithecia.

Cultivated specimens: On cow dung, New York City, Aug. 1899; cow dung, Englewood, N. J., Sept. 1899.

The species appears to be very rare even in the vicinity of New York City, as only small quantities of it were obtained in either of the above cultures. Although the spores are described as uniseriate one is very liable to consider them loosely biseriate on account of the arrangement of the exceedingly long primary appendages. These curve alternately in opposite directions, whence each one overlaps the spore below. In this arrangement a slight disturbance causes the alternate spores to separate out loosely into two series. It is often difficult here as in *P. coprophila* to find asci with mature spores. In all of the perithecia studied not more than three asci with brown spores were found in any of them. The hairiness of the perithecia disappears with age, when they look much like old perithecia of *P. coprophila.* But they may be distinguished even in this stage by being less coriaceous and lighter in color. The spores as stated above are exceedingly variable. Often the septum which separates the fertile cell from the primary appendage is moved downward in such a way as to form a spore which has an ovate outline with a short black stalk. Again the apex of the spore may be prolonged slightly as shown in some of the figures. These variations appear to be due to a lack of uniformity in the enlargement of the apex of the original cylindrical spore together with a similar irregularity in the position at which the septum is formed after the protoplasmic contents move to the upper part of the spore.

15. PLEURAGE ZYGOSPORA (Speg.) Kuntze, Rev. Gen. Plant. 3^3: 505. 1898

Sordaria zygospora Speg. Michelia, **1**: 227. 1878.

Philocopra zygospora (Speg.) Sacc. Syll. Fung. **1**: 251. 1882.

Perithecia scattered, sunken or nearly superficial, when they

are more or less covered with a dense or arachnoid fuscous mycelium, about 500 × 750 μ, thin, membranaceous, somewhat transparent, greenish below and black above, pyriform with a more or less elongated cylindrical black bare and curved beak.

Asci primarily 8-spored, cylindrical to clavate, broadly rounded above and contracted below into a long slender crooked stipe, very evanescent, 42–54 μ × 250–320 μ: paraphyses ventricose, tapering upward, septate, agglutinated, longer than the asci and not mixed with them.

Spores consisting of an ellipsoid to ovate fertile cell rounded at both ends, but usually more acutely so distally, at each end of a long spirally arranged hyaline fugacious filament which corresponds to the primary appendages in the other species; terminal fertile cells 13–19 μ × 24–40 μ; secondary appendages consisting of usually 4 rather short tapering hyaline gelatinous widespread processes attached to the distal ends of the fertile cells. (*Pl. 9. f. 1–4.*)

Distinctive character: Spore consisting of a fertile cell at each end of a long twisted filament.

Cultivated specimens: On cow, horse, and goat dung, Ft. Lee, N. J., summer, 1899; sheep dung, Meridian, N. Y., Aug. 1899 (Banker); cow dung, Baldwinsville, N. Y., Aug. 1899 (Banker); horse dung, Aberdeen, S. D., Sept. 1899 (Towne); horse dung, Doland, S. D., July 1899 (Carter); cow and horse dung, Huron, S. D., July 1899 (Carter); cow dung, Redfield, S. D., July 1899 (Carter); cow dung, Highmore, S. D., Sept. 1899 (Carter); cow, horse, and pig dung, Brookings, S. D., Nov. 1899 (Carter); horse and cow dung, Austin, Texas, Jan. 1900 (Long); cow and horse dung, Rooks Co., Kan., July 1899 (Bartholomew); horse dung, London, Ontario, Aug. 1899 (Dearness); cow dung, Emma, Mo., Aug. 1899 (Demetrio); horse and pig dung, De Soto, La., July 1899 (Frierson).

This is one of the most peculiar, interesting and variable species in the whole group. Occasionally fertile cells have been found which were very narrow and oval in outline. The Texas specimens were especially variable. Several perithecia were found in which the entire filament joining the fertile cell had been transformed into a brown solid structure resembling that of the spore proper. Occasionally secondary appendages may be found at both ends of the fertile cells, but this appears to be an exception; the ones at the proximal end always being less distinct and more fugacious.

16. **Pleurage vestita** (Zopf)

Eusordaria vestita Zopf, Zeitschrift gesammt. Naturwissenschaften (Halle), **56**: 556. *pl. 6. f. 10–19.* 1883; Schenk, Handbuch der Bot. **4**: 362. *f. 60.* 1890.

Podospora vestita (Zopf) Rehm; Rabenhorst Kryptogamen-Flora, 1^2: 176. 1887.

Perithecia usually more or less sunken, but often quite superficial, scattered or aggregated in a dense growth of brown or olivaceous mycelium which covers the perithecium up to the black bare curved or straight cylindrical beak, pyriform, thin, membranaceous, black above but greenish below, especially in the sunken portions which are so transparent that the asci and spores can be quite distinctly seen, 400–525 $\mu \times$ 675–825 μ.

Asci 8-spored, clavate, contracted and rounded above, and tapering below into a medium sized pedicel, very evanescent 40–55 $\mu \times$ 180–210 μ: paraphyses ventricose, very evanescent, longer than the asci.

Spores biseriate, ellipsoid to ovate, rounded above and below, but more narrowly so above, ranging from hyaline when young through olivaceous to dark brown and opaque, 18–22 $\mu \times$ 28–35 μ: spore terminated below by a cylindrical primary appendage as long as the spore or slightly longer, which is tipped with three or four long gelatinous appendages which are similar in all respects to those found at the apex of spore. (*Pl. 9. f. 5–8.*)

Distinctive characters: Abundant mycelium and the four terminal gelatinous secondary spore appendages.

Cultivated specimens: On cow dung, New York City, May 1899; cow dung, Ft. Lee, N. J., July 1899; horse dung, Englewood, N. J., Sept. 1899; cow and sheep dung, Meridian, N. Y., Aug. 1899 (Banker); cow dung, Newfield, N. J., Aug. 1899 (Ellis); dead culms of *Eleocharis palustris*, Aberdeen, S. D., May 1896; rabbit, sheep, horse, and cow dung, Tucson, Ariz., Jan. 1900 (Tyler); horse dung, Gunnison, Colo., Aug. 1899 (Bartholomew); horse and cow dung, Emma, Mo., Aug. 1899 (Demetrio); horse, cow, and sheep dung, Mesilla Park, N. M., Jan. 1900 (Wooton); cow, horse, and pig dung, De Soto, La., Aug. 1899 (Frierson); horse and cow dung, Brookings, S. D., July 1899 (Carter); horse dung, Redfield, S. D., Sept. 1899 (Carter); horse and rabbit dung, Highmore, S. D., Aug. 1899 (Carter); cow, rabbit, and horse dung, Austin, Texas, Jan. 1900 (Long).

Dr. Rehm* reports this as being a very rare and imperfectly understood species. Indeed there is no record at hand of its ever having been collected by anyone except Dr. Zopf who originally figured and described it. The wide distribution which it has in this country would rather lead one to infer that it is more abundant, however, in Germany than our literature testifies. Dr. Zopf described the plant as being densely covered with hairs or rhizoids. This is a common but not an invariable characteristic of the American plant. This feature, as has been stated, depends here as in other species upon the amount of moisture present. By chance some of the Missouri material was divided into two parts and cultivated in separated chambers. One culture was kept rather moist while the other was rather drier than usual. The first produced almost no hairs at all above the substratum while the latter corresponded exactly with Zopf's description. Both the Missouri and the Meridian, N. Y., material produced perithecia in great abundance. In either case, three times the number of perithecia would have completely covered the substratum. In the case of the Aberdeen specimens on culms of *Eleocharis palustris*, it should be stated that the material was collected in May 1896, in a pond which contained considerable rubbish.† This species matured on this substratum in about one month after being placed in a moist chamber. It is, therefore, not to be supposed that the fungus is in any way parasitic or even partial to this substratum.

17. PLEURAGE CALIFORNICA (Plowr.) Kuntze, Rev. Gen. Plant. 3^3: 505. 1898

Sordaria Californica Plowr. Grevillea, **7**: 72. *pl. 120. f. 2.* 1878.

Podospora Californica (Plowr.) E. & E., N. Am. Pyren. 132. 1892.

Perithecia large, covered with a dusky brown felt, superficial, crowded or scattered, about 1 mm. high: ostiolum naked, rugose, often thrown into parallel diverging striae: sporidia ellipticofusiform, lower end truncate, appendiculate, 30–35 $\mu \times$ 15–18 μ: asci about 200–300 μ long.

On cow dung. A very well marked and interesting species.

* Rabenhorst, Kryptogamen-Flora.

† See Bull. Torr. Club, **26**: 443. 1899.

The sporidia are developed from cylindrical bodies, as in *P. coprophila*.

The above is a copy of Plowright's original description to which but little can be added. Dr. Plowright has had the kindness to send me a portion of his type, which is in a good state of preservation for these species, but from it little can be added to the original description and figures. An examination of the type, however, has led to the conviction that this is distinct from all

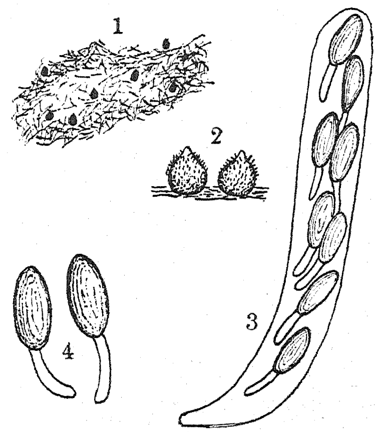

FIG. 5. *Pleurage Californica* after Plowright. 1, substratum slightly magnified; 2–4, perithecia, ascus and spores.

other American species and that the spores are tipped at the upper end as well as at the lower end of the primary appendage by long lash-like gelatinous hyaline secondary appendages, whose exact character cannot be determined from the dry specimens. Cultures of California material will doubtless yield specimens of this species. But until cultures are made, nothing can be added to our knowledge of the species, although the type is extant.

18. PLEURAGE STRIATA (E. & E.) Kuntze, Rev. Gen. Plant. 3^1: 504–505. 1898

Sordaria striata E. & E., Jour. Mycol. 4: 79. 1888.

Podospora striata (E. & E.) N. Am. Pyren. 131. 1892.

Gregarious. Perithecia ovate, conical, .65 mm. high and .5 mm. broad, black tubercular-roughened, the tubercles seriate above so as to cause the conical ostiola to appear striate: the tubercles are at first capped with a few light-colored granules, like grains of

white sugar, but these at length disappear: asci linear-lanceolate, contracted towards each end and perforate above, 200 μ long and over (including the filiform base), and 12–15 μ wide, with abundant paraphyses: sporidia biseriate, elliptical, brown, 14–16 $\mu \times$ 8–10 μ, the upper end acute or with a short hyaline appendage 8–12 μ long, the lower end prolonged into a yellowish-hyaline cylindrical curved appendage 35–40 $\mu \times 5 \mu$.

On "decaying weed" Pointe à la Hache, P. O., La. (Langlois).

The above description is taken from North American Pyrenomycetes. From the dried specimens at hand, I am unable to distinguish a perforation in the ascus as described.

19. **Pleurage albicans** (Alb. & Schw.)

Sphaeria albicans Alb. & Schw. Conspectus fungorum, 36. 1805.

Sphaeria coprophila Fries; Kunze, Myc. Hefte, **2**: 38. 1823; Systema Mycologicum, **2**: 342. 1823.

Hypoxylon coprophilum Fries, Summa Veg. Scand. **2**: 384. 1849.

Podospora coprophila (Fries) Rehm; Rabenhorst, Krypt.-Flora, $\mathbf{1}^2$: 172. 1887; N. Am. Pyren. 129. 1892.

Sordaria coprophila (Fries) Ces. & DeNot. Comment. Soc. Crit. Ital. **1**: 226. 1863; Abhand. naturforsch. Gesell. zu Halle, **13**: 90. *pl. 9. f. 14.* 1877; Cohn's Krypt.-Flora Schlesien, $\mathbf{3}^3$: 287. 1894.

Pleurage coprophila (Fries) Kuntze, Rev. Gen. Plant. $\mathbf{3}^3$: 505. 1898.

Perithecia scattered and half sunken, or aggregated and even confluent in groups which cover large areas of the substratum, 450–600 $\mu \times$ 750–900 μ; all exposed portions except the beak covered with a white tomentum which disappears with age and moisture, pyriform, with papilliform ostiolum, coriaceous, black and opaque.

Asci 8-spored, cylindrical to slightly clavate, rounded above and contracted below into a long slender stipe, very evanescent and with a hyaline homogeneous highly refractive particle in the apex, 15–22 $\mu \times$ 125–200 μ: paraphyses very evanescent, ventricose, agglutinated, longer than the asci.

Spores biseriate, ellipsoid to ovate, 9–11 $\mu \times$ 18–30 μ, ranging from hyaline when young through olivaceous to dark-brown and

opaque; primary appendage twice as long as the spore, cylindrical, curved; this as well as the apex of the spore tipped with a long lash-like gelatinous fugacious secondary appendage. (*Pl. 5. f. 10–13.*)

Distinctive characters: White tomentum and black leathery perithecia.

Cultivated specimens: On horse dung, New York City, March 1900; cow dung, greenhouse of Columbia University during entire winter of 1899–1900; cow dung, Englewood, N. J., Aug. 1899; cow dung, Schaghticoke, N. Y., Aug. 1899 (Banker); cow and horse dung, Auburn, Ala., Aug. 1899 (Earle); cow dung, Brookings, S. D., Nov. 1899 (Carter).

A very interesting species from the fact that mature spores are seldom met with. Cultures have been examined two or three times a month without finding a single mature spore. There appears to be no question but that immature spores are ejected from the perithecium and that only under certain circumstances are mature ones produced. Indeed only about a half dozen asci with mature spores have been found during the entire time that the species has been studied. Often one may find asci in which the spores are slightly enlarged at the end, but it is seldom that they can be found in even the olive-green stage. In the vast majority of cases they are simply the long cylindrical curved, guttulate structures that are the forerunners of the spores of so many species of this genus. The asci enlarge readily when forced from the perithecium under the cover-glass, and act in all respects like the mature asci of other species. Immature spores have never been seen ejected out of the ostiolum, although they have often been found in globular masses on the apex of the perithecium. My views in this matter are strengthened by the fact that Woronin * found that the immature spores of this as well as other species of the genus germinate readily in water, producing mycelium and conidia. My experiments confirm Woronin's work as far as the production of mycelium, but the cultures were spoiled before the conidial stage was reached. It would seem that the plant has adopted this more speedy method of propagation when circumstances are favorable for such a method; but that these immature

*Abhand. Senk. naturforsch. Gesell. 7: 325–360. 1870.

spores are unable to withstand unfavorable conditions. This necessitates the production of the ordinary thick-walled chitinous spore.

A fine specimen of this species is found in Rehm's Ascomycen, *no. 234*, but in the half dozen or more perithecia examined no mature spores seen could with certainity be referred to them. They were in exactly the same condition of development as the American plants are when usually examined. One can produce the white tomentum on the perithecia or prevent its development at will. In the presence of a large quantity of moisture there occurs no sign of tomentum, but the perithecia develop normally and are black and smooth. If the culture is now allowed to become comparatively dry, the tomentum again appears on the younger perithecia.

20. **Pleurage longicaudata** sp. nov.

Perithecia scattered, sunken, but becoming half exposed at maturity, 450–600 $\mu \times$ 600–900 μ, thin, membranaceous, greenish below when young, but finally becoming black and opaque, globular to pyriform with short narrow cylindrical black bare beak.

Asci clavate, straight or curved, contracted and narrowly rounded above and tapering below into a short broad stipe, very evanescent, 32–42 $\mu \times$ 280–300 μ: paraphyses very wide, tubular-ventricose, irregular, tapering upward, slightly longer than the asci.

Spores ellipsoid, rounded at the ends, but usually more acutely so above, 23–25 $\mu \times$45–53 μ, ranging from hyaline when young through olivaceous to dark brown and opaque; primary appendages pestle-shaped, about two-thirds the length of the spore; secondary appendages covering the entire spore and primary appendages as well, being shortest around the equator, increasing in length towards the ends where they become united into a very long slender fugacious hyaline gelatinous striate-frayed filament. (*Pl. 8. f. 9–11.*)

Distinctive character: The spore appendages.

Cultivated specimens: On cow dung, Rooks Co., Kan., July 1899 (Bartholomew); cow dung, Auburn, Ala., Aug. 1899 (Earle); horse dung, Austin, Tex., Jan. 1900 (Long); cow dung, De Soto, La., Aug. 1899 (Frierson).

This is a very striking species which must be studied at the time of maturity if one wishes to thoroughly appreciate the beauty

and complexity of the secondary appendages. Their true character is liable to be entirely overlooked in the dried specimens. The asci are also so fugaceous that it is next to impossible to remove one with perfectly mature spores from the perithecium. The accompanying illustrations and measurements were made from asci in which the spores were in the olive-green stage for reasons stated above.

21. PLEURAGE DECIPIENS (Wint.) Kuntze, Rev. Gen. Plant. 3^3: 505. 1898

Sordaria decipiens Wint. Abhand. naturforsch. Gesell. zu Halle, **13**: 95. *pl. 9. f. 16.* 1873; Fuckel, Symb. Mycol. Append. 2: 44. *pl. 1. f. 33.* 1873; Cohn's Krypt.-Flora Schlesien, 3^2: 287. 1894; Schenk, Handbuch der Bot. **4**: 362. *f. 60.* 1890; Sacc. Syll. Fung. **1**: 235. 1882; Naturhist. Forening Kjobenhaven Vidensk. Middelelser for Aarene, 342, 352. *pl. 7. f. 25–26.* 1876.

Eusordaria decipiens (Wint.) Zopf, Zeitschrift gesammt. Naturwiss. **56**: 542 *pl. 6. f. 20–22.* 1883.

Podospora decipiens (Wint.) Rehm; Rabenhorst, Kryptogamen-Flora, $\mathbf{1}^2$: 173. *f. 1–3.* 1887.

Perithecia pyriform, sunken in the substratum, scattered, 300–450 μ × 575–750 μ; walls thin, membranaceous, black above and greenish below, often so transparent that the asci and spores can be indistinctly seen by transmitted light; beak moderately long, straight or curved, and often roughened above by a few short papillae; rhizoids abundant and extending up to the projecting usually curved black beak.

Asci 8-spored, clavate, rounded above and contracted below into a pedicel of medium length, evanescent, 40–55 μ × 180–240 μ: paraphyses long, ventricose, septate, agglutinated, abundant, but not much mixed with the asci.

Spores biseriate, ellipsoid to ovate, slightly wider below the middle, 20–24 μ × 38–54 μ; color ranging from hyaline when young through olivaceous to dark brown and opaque: germinal pore large, apical and eccentric; lower end of spore terminated by a long cylindrical primary appendage, 1–1.5 times the length of the spore; the base of this appendage being surrounded by short gelatinous secondary appendages, while the apex of the spore is crowned by a lyre-shaped tuft of similar consistency. (*Pl. 9. f. 10–13.*)

Distinctive character: The spore appendages.

Cultivated specimens: On cow dung, Fort Lee, and horse dung, Englewood, N. J., July 1899; cow, sheep, and horse dung, Newfield. N. J., Aug. 1899 (Ellis); cow and horse dung, Rooks Co., Kan., July 1899 (Bartholomew); horse dung, New York City, Oct. 1899; horse dung, Aberdeen, S. D., Oct. 1895; horse, cow, and prairie dog dung, Highmore, S. D., July 1899 (Carter); rabbit and muskrat dung, Bronx Park, N. Y., Jan. 1900 (Percy Wilson); cow dung, Proctor, Vt., Aug. 1899 (Banker); cow and horse dung, London, Canada, Aug. 1899 (Dearness); horse, dog, and cow dung, Austin, Tex., Jan. 1900 (Long); cow dung, Kingston, R. I., Dec. 1899 (Underwood); horse, cow, and rabbit dung, Tucson, Ariz., Jan. 1900 (Tyler); cow dung, Auburn, Ala., Aug. 1899 (Earle); horse dung, Mesilla Park, N. M., Jan. 1900 (Wooton); cow and horse dung, Biloxi, Miss., Sept. 1899 (Tracy); horse and cow dung, Summit, Family, and Great Falls, Mont., Aug. 1900 (Griffiths & Lange); horse dung, Benson, Ariz., Oct. 1900.

This is a very common and widely distributed species which naturally exhibits considerable variety in many of its characteristics. Often, when the perithecia are completely sunken in the substratum, they are transparent enough to enable one to study the behavior of the asci in ejection of the spores, while at other times, when they are more or less superficial, the perithecium wall is black and opaque. Very often the beak of the perithecium is perfectly smooth. Externally the perithecia resemble those of *P. vestita* very closely. The lyre-shaped tuft of appendages on the apex of the spore is subject to great variation. Each gelatinous filament appears to be made up of two parts, a distal very fugacious and a proximal more persistent one. In the young state the distal portions appear fused and show their true structure only at maturity.

22. **Pleurage Kansensis** sp. nov.

Perithecia scattered or aggregated, sunken or nearly superficial, exposed portion covered with long flexuous olivaceous to brown septate hairs, 375–450 $\mu \times$ 600–800 μ, thin, membranaceous, greenish below when young, but becoming completely black and bare at maturity: beak papilliform to cylindrical, black, bare and usually curved.

Asci 8-spored, cylindrical, broadly rounded above and contracted below into a short slender stipe, 26–32 $\mu \times$ 180–240 μ,

evanescent: paraphyses ventricose, agglutinated, abundant, longer than the asci and not mixed with them.

Spores obliquely uniseriate, ellipsoid, rounded at both ends, $18–21\ \mu \times 26–35\ \mu$, ranging from hyaline when young through olivaceous to dark brown and opaque; primary appendage entirely absent; secondary appendage attached to each end of the spore, long, gelatinous, evanescent, and composed of two closely united filaments, which appear to fuse distally; these in turn are striated longitudinally, making them appear as though they were formed of still smaller subdivisions. (*Pl. 8. f. 6–8.*)

Distinctive characters: Hairy perithecium and absence of primary appendages.

Cultivated specimens: On cow dung, Rooks Co., Kan., July 1899 (Bartholomew); horse and cow dung, Austin, Texas, Jan. 1900 (Long); horse and cow dung, Tucson, Ariz., Jan. 1900 (Tyler); cow dung, Bookings, S. D., Nov. 1899 (Carter).

The Tucson specimens had perfectly smooth perithecia from the beginning as far as could be seen, but the substratum was very wet. One may often find in this species 4–8-spored asci. This variation is clearly due to the abortion of four of the spores, and not to a failure of the nuclei to divide the third time; for while four spores are in the olive-green stage four other abortive hyaline ones may usually be found. Later in development these disappear entirely when there occurs a 4-spored ascus differing from the normal in no other respect than that of size.

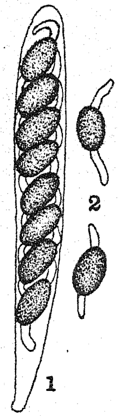

FIG. 6. *Pleurage brassicae* after Brefeld. 1, ascus; 2, spores.

23. PLEURAGE BRASSICAE (Kl.) Kuntze, Rev. Gen. Plant. 3^3: 505. 1898

Sphaeria brassicae Klotzsch; Smith, Eng. Flora, 5^2: 261. 1836.

Sphaeria lanuginosa Preuss. Linnaea, **26**: 714. 1853.

Sordaria lanuginosa (Pr.) Sacc. Syll. Fung. **1**: 237. 1882; Cohn's Krypt.-Flora Schlesien, 3^2: 287.

Podospora brassicae (Kl.) Rehm; Rabenhorst's Krypt.-Flora, 1^2: 171. 1887; N. Am. Pyren. 132. 1892.

Perithecia often aggregated, globular, with conical beak, covered with quite long prominent gray tomen-

tum which becomes less conspicuous upward, about 0.7 mm. × 1 mm.: asci 8-spored, cylindrical-clavate, slightly contracted above and narrowed below into a long stipe, 200–300 μ (p. sp.) × 34–40 μ: spores obliquely uniseriate or irregular, ovate-elliptical and tipped at each end with one or more hyaline fugacious, curved appendages, dark brown and glossy, 20–30 μ × 42–55 μ: paraphyses delicate, filiform, agglutinated.

No specimens of this have been seen. It was reported by Dr. Harkness on stems of *Lupinus arboreus* from California. The description is after Rehm and the figures of ascus and spores after Brefeld.

24. **Pleurage multicaudata** sp. nov.

Perithecia scattered, half-sunken, about 600 × 900 μ, slightly coriaceous, greenish below when young, but finally becoming black and opaque, pyriform to globular with papilliform to cylindrical black curved beak, bearing bunches of long straight dark brown sparingly septate hairs on its convex side; the lower portion uniformly clothed with long flexuous brown septate hairs.

Asci 8-spored, clavate, straight or curved, contracted and rounded above and tapering below into a narrow short stipe, quite persistent, 42–58 μ × 225–260 μ: paraphyses wide, tubular-ventricose and but little longer than the asci.

Spores biseriate, ellipsoid to oblong, rounded at both ends, 20–25 μ × 40–55 μ: ranging from hyaline when young through olivaceous or yellow to dark brown and opaque; primary appendages entirely absent; the secondary forming short awl-shaped gelatinous very fugacious hyaline projections covering the entire spore; these are shortest about the equator and gradually increase in length toward the ends of the spore, but never reach a length equal to it. (*Pl. 6. f. 7–9.*)

Distinctive characters: The tufts of hair on the beak of the perithecium and the short appendages covering the entire spore.

Cultivated specimens: On cow dung, Highmore, S. D., Aug. 1899 (Carter); cow dung, Biloxi, Miss., Aug. 1899 (Tracy). The Biloxi specimen was sent to me under a number and contained good material when received, but the number was lost during cultivation.

In order to appreciate the beauty of this species it must be examined at maturity, for the appendages lose their identity to a large extent and become irregular homogeneous masses attached to the spore at various points or disappear entirely. It will be seen that the transition from this species to one which has a

gelatinous envelope surrounding its spores is very slight indeed. It is on account of these transitional forms that Schroeter and Lindau object to the recognition of genera based on these characteristics.

25. PLEURAGE LUTEA (E. & E.) Kuntze, Rev. Gen. Plant. 3^3: 505. 1898

Sordaria lutea E. & E. Jour. Mycol. **3**: 118. 1887; Saccardo, Syll. Fung. **9**: 486. 1891.

Philocopra lutea (E. & E.) E. & E., N. Am. Pyren. 132. 1892.

Perithecia superficial, gregarious or scattered, about .5 × .75 mm., pyriform, slightly coriaceous, and completely covered, with the exception of the black bare papilliform beak, with a persistent light yellow tomentum composed of branching and slightly roughened hair.

Asci clavate, rounded above and contracted below into a moderately long stipe, 14–17 μ × 135–200 μ: paraphyses not seen.

Spores 12–16 in an ascus, at first vermiform and greenish yellow, finely almond-shaped and opaque, 7–8 μ × 14–16 μ; primary appendage cylindrical, curved, 30–35 μ × 4 μ; secondary appendage short, slender and attached to apex of the spore.

Distinctive character: The tomentum of the perithecium.

Dry specimens: On decaying *Kalmia*, Newfield, N. J., Nov. 1879 (Ellis); on dead *Rhus Toxicodendron*, Long Island, N. Y., Apr. 1889 (Zabriskie); on rotten maple, Newfield, N. J., Aug. 1887 (Ellis).

As will be easily recognized, the greater part of the description of this species is drawn from the original of Mr. Ellis. Although the specimens at hand are abundant, there are none of them in good condition for study. The species appears somewhat similar to *P. coprophila* as regards the condition of the spores in the perithecium. In none of the specimens before me are there any mature spores; the great majority of them are completely cylindrical while a few have slightly swollen ends.

26. **Pleurage heterochaeta** sp. nov.

Perithecia superficial or with base slightly sunken, scattered, thin, membranaceous, olivaceous in sunken portions but fuscous above with blackened apex, somewhat transparent, about 450 μ × 700 μ; all exposed portions except the black bare papilliform beak covered with short blunt transversely or obliquely septate

agglutinated hairs, which are prominent around the base of the beak and decrease to mere scattered papillae downward; uniformly scattered among the latter are long filiform flexuous septate brown hairs, which gradually become transformed below into the rhizoids, which ramify through the substratum.

Asci 16-spored, cylindrical-clavate, contracted and narrowly rounded above and contracted below into a short stout stipe, $34-40\,\mu \times 230-240\,\mu$; very evanescent: paraphyses exceedingly ventricose, agglutinated and not at all mixed with the asci, often very indistinct and appear more like a tissue lining the perithecium than like filaments.

Spores biseriate, ellipsoid, broadly rounded at both ends, $18-20\,\mu \times 27-34\,\mu$; primary appendages entirely wanting, the apex of the spore tipped with two awl-shaped parallel or slightly divergent rather firm gelatinous appendages, which in the ascus are curved so as to appear as one; lower end of the spore bearing two similar appendages but much more delicate curved and variously twisted appendages. (*Pl. 17. f. 1–3.*)

Distinctive characters: Hairs of perithecia and absence of primary appendages.

Cultivated specimens: On cow dung, Family, Mont., Sept. 1900.

27. **Pleurage Dakotensis** sp. nov.

Perithecia scattered, superficial or with the base slightly sunken, pyriform with papilliform to conical curved beak, about $375 \times 600\,\mu$, thin, membranaceous, fuscous, transparent and covered, especially above, by tufts of agglutinated obliquely-septate fuscous hairs.

Asci 32-spored, clavate, broadly rounded above and contracted below into a short stipitate base, rather persistent, $30-40\,\mu \times 175-220\,\mu$: paraphyses slightly ventricose, septate, longer than the asci, but not mixed with them.

Spores in 2–4 series, ellipsoid to slightly ovate, rounded at the ends, $12-15\,\mu \times 18-23\,\mu$, ranging from hyaline when young through olivaceous to dark brown and opaque: primary appendage short, cylindrical, straight and fugacious; secondary appendages tipping the primary and the apex of the spore, long, lash-like and very fugacious. (*Pl. 7. f. 17–19.*)

Distinctive characters: Many-spored ascus and agglutinated hairs of the perithecium.

Cultivated specimens: On rabbit dung, Ft. Lee, N. J., Jan. 1900; Cow dung, Brookings, S. D., Nov. 1899 (Carter); cow dung, Austin, Texas, Jan. 1900 (Long); rabbit dung, Auburn,

Ala., Aug. 1899 (Earle); dead stems of *Salsola Kali tragus*, Aberdeen, S. D.

In a former paper* this species was published as *Sordaria pleiospora* Wint., but subsequent study has proven beyond a doubt that it is an entirely different thing. Indeed it is difficult now to see how this could have been mistaken for the above. As conceived at present the species has quite a range of variation. The simple hairs of the perithecium are generally absent; in only a few instances, in the Alabama specimens, have they been found aside from the Aberdeen forms in which they appeared quite constant. The New Jersey, Texas, and Brookings, S. D., cultures show no signs of any perithecial ornamentation except the fasiculated hairs mentioned in this description.

The species appears most closely related to *P. curvula* from which it differs mainly in size and the number of spores in the ascus.

28. PLEURAGE CURVICOLLA (Wint.) Kuntze, Rev. Gen. Plant. 3^3: 505. 1898

Sordaria curvicolla Wint. Hedwigia, **10**: 161. 1871; Abhand. naturforsch. Gesell. zu Halle, **13**: 98–99. *pl. 10. f. 19.* 1873; Griffiths, Bull. Torr. Club, **26**: 437. *pl. 365. f. 13–15.* 1899.

Philocopra curvicolla (Wint.) Sacc. Syll. Fung. **1**: 250. 1882.

Perithecia sunken, scattered, but often erumpent and half superficial at maturity, 350–450 μ × 550–600 μ, thin, membranaceous, transparent, greenish to fuscous, pyriform with black projecting rather stout papilliform beak, which is ornamented mostly below the middle, with bunches of long nearly straight acuminate very sparingly septate greenish to brown hairs.

Asci 128–256 (?)-spored, widely clavate to sac-like, broadly rounded above and contracted below into a short stipe, 70–120 μ × 225–280 μ: paraphyses tubular to filiform, tapering upwards, septate, longer than the asci.

Spores in many series, ellipsoid or slightly ovate, 10–11 μ × 13.5–16 μ; ranging from hyaline when young through olivaceous to dark brown and opaque, terminated below by a short primary appendage; this in turn, as well as the apex of the spore, is tipped with a long lash-like gelatinous hyaline very fugacious secondary appendage. (*Pl. 10. f. 1–6.*)

* Bull. Torr. Club, **26**: 438. 1899.

Distinctive characters: Tufts of hairs on the perithecium and the large number of small spores.

Cultivated specimens: On horse and cow dung, New York City, Aug. 1899; rabbit dung, Ft. Lee, N. J., Nov. 1899; rabbit dung, Rooks Co., Kan., July 1899 (Bartholomew); horse, rabbit, and cow dung, Auburn, Ala., Aug. 1899 (Earle); horse dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

The species varies greatly in characteristics of the hairs on the beak of the perithecium. In some specimens from the vicinity of New York, the perithecia had almost no hair at all on them, while others were densely covered. The same thing may be said of the Kansas specimens also.

The number of spores in the ascus is usually given as 128. This figure is based on an account given by Winter. He counted the number in one or two asci and found them to be as given above. In my specimens the number is almost invariably greater than this. In but a single case have 128-spored asci been found and that in one of the Alabama cultures. As high as 200 spores have been counted, and it was known at the same time that all of them could not be seen on account of the great number in the ascus. It is thought therefore that the number follows the regular law which would give us here 8 mitotic divisions and 256 spores. On account of the difficulty of isolating the delicate asci it is difficult to determine the exact number with any degree of certainty.

29. **Pleurage collapsa** sp. nov.

Perithecia scattered or aggregated, one-half to two-thirds immersed, 400–450 $\mu \times$ 500–600 μ, thin membranaceous, at first greenish below but soon becoming brown, pyriform to subglobose with papilliform to short cylindricial black beak, the base of which, like the upper exposed portion of the perithecium, is uniformly covered with long flexuous septate brown hairs.

Asci 64-spored, fusiform, contracted and sharply rounded above and contracted below into a short blunt stipe, very evanescent, about 65 $\mu \times$ 210 μ: paraphyses ventricose, agglutinated, largest near the middle, longer than the asci, but not much mixed with them.

Spores in several series, ellipsoid and broadly rounded at the ends, 10–14 $\mu \times$ 18–21 μ, ranging from hyaline when young through olivaceous to dark brown and opaque; primary append-

age very long and slightly clavate when young, but at maturity becomes very much shriveled and indistinguishable from the short blunt secondary appendages which terminate it as well as the apex of the spore. (*Pl. 10. f. 14–18.*)

Distinctive characters : Hairy perithecia, and character of primary appendage.

Cultivated specimens : On rabbit dung, Bronx Park, N. Y., Jan. 1900 (Mr. Percy Wilson); rabbit dung, Auburn, Ala., Aug. 1899 (Earle).

This species is one of those that is very distinct from everything else, but at the same time its characters are very inconstant and therefore difficult to define. The first culture made had hairy perithecia as described above and this is taken to be the normal condition of the plant. The substratum which was in a Petri-dish was then allowed to dry for about ten days. On again moistening another crop appeared ; but this time the culture was kept very wet. No hairs at all could be seen without mounting the perithecia, and even then it was very difficult to tell whether the hairs seen were really comparable to the aërial ones of the other perithecia for they were completely matted on the substratum and much fewer in number than in the first culture. This condition would not be liable to occur in nature.

The collapsing of the primary appendage is comparable to a similar phenomenon which occurs in that of *P. decipiens*, but here it is much more marked. The gelatinous secondary appendages may often present a long lash-like appearance, but this condition can be produced at will by rough treatment of the mount.

30. PLEURAGE PLEIOSPORA (Wint.) Kuntze, Rev. Gen. Plant. 3^3 : 504. 1898 *

Sordaria pleiospora Wint. Hedwigia, **10** : 161. 1871 ; Abhand. naturforsch. Gesell. zu Halle, **13** : 93–97. *pl. 10. f. 17.* 1873 ; Cohn's Krypt.-Flora Schlesien, 3^2 : 288. 1894.

Podospora pleiospora (Wint.) Rehm ; Rabenhorst, Krypt.-Flora, 175. 1887.

Philocopra pleiospora (Wint.) Sacc. Syll. Fung. **1** : 249. 1882.

Perithecia scattered and sunken but becoming more or less

* The plant reported under this name in Bull. Torr. Club, **26** : 438. 1899 does not belong here at all ; see *P. Dakotensis*.

free with age, $375–525\,\mu \times 550–750\,\mu$, thin, membranaceous, greenish below, often somewhat transparent, pyriform with papilliform to somewhat elongated cylindrical black bare usually curved beak, the whole lower portion of the perithecium and often the surface of the substratum covered with a considerable growth of mycelium in the form of rhizoids.

Asci 64-spored, clavate to fusiform, contracted and narrowly rounded above and contracted below into a short narrow stipitate base, evanescent, $60–110\,\mu \times 250–300\,\mu$: paraphyses ventricose below, tubular septate above, longer than the asci.

Spores in several series, ellipsoid, rounded at both ends but usually more broadly so below, $18–22\,\mu \times 32–37\,\mu$, ranging from hyaline when young through olivaceous to dark brown and opaque; primary appendage cylindrical, equal to or longer than the spore; the base of this is surrounded with 2 to 4 hyaline gelatinous secondary appendages of various form and size, the apex of the spore being crowned by a tuft of very fine filaments closely united into a short blunt straight or curved appendage. (*Pl. 10. f. 7–10.*)

Distinctive characters: The spore appendages.

Cultivated specimens: On cow and horse dung, New York City and Ft. Lee, N. J., summer 1899; cow dung, Biloxi, Miss., Sept. 1899 (Tracy); cow dung, Auburn, Ala., Aug. 1899 (Earle).

Both the perithecia and the spores of this species resemble those of *P. decipiens* very closely. The upper appendage of the spores, however, is narrower and longer and contains fewer filaments in its composition.

The measurements given are those of the New York specimens which were very thoroughly studied when the species was first found. The Alabama specimens show considerable variation in spore measurements, some being as low as $16\,\mu \times 27\,\mu$; these it appears to me had best be treated as simply a variation in the species because no other differences were observable.

31. **Pleurage adelura** sp. nov.

Perithecia sunken, scattered; about $450\,\mu \times 750\,\mu$, thin, membranaceous, brown and opaque, pyriform, with a smooth, black papilliform to cylindrical projecting beak.

Asci 64-spored, fusiform-clavate, contracted and narrowly rounded above and tapering below into a stout stipe, about $75\,\mu$

× 370 μ: paraphyses ventricose, agglutinated, irregular, longer than the asci, but not mixed with them.

Spores in several series, ellipsoid, broadly rounded at both ends, 13–19 μ × 26–32 μ, ranging from hyaline when young through olivaceous to dark-brown and opaque: primary appendage wide, cylindrical, shorter than the spore and quite persistent; secondary appendages terminating the primary and apex of the spore, at first long delicate filaments made up of two strands, but at maturity appearing like two short irregular projections with very uncertain characters. (*Pl. 10. f. 11–13.*)

Distinctive characters: Fugacious character of secondary appendages and comparatively short and wide primary ones.

Cultivated specimens: On rabbit dung, Auburn, Ala., Aug. 1899 (Earle).

The species is very closely related to *P. pleiospora*, as will be readily seen from the figures and description. The spore appendages are, however, very distinct and characteristic in the two species. In the former species they are readily recognized, but here it is with the greatest difficulty that one is able to isolate the spores without destroying them. Even when undisturbed, a good deal of them has disappeared by the time the spores are ripe. The best place to study these appendages is in the rather young ascus as it stretches under the cover-slip. Here they can with difficulty be discerned. It does not seem possible that the appendages can be of much use in the distribution of spores in this species.

32. PLEURAGE CANINA (Peck) Kuntze, Rev. Gen. Plant. **3**^{3}: 505. 1898

Sphaeria canina Peck, Reg. Rep. **28**: 78. 1875.

Philocopra canina (Peck) Sacc. Syll. Fung. **1**: 251. 1882; Ellis & Everhart, N. Am. Pyren. 133. 1892.

The author has been unable to examine the original of the above in the New York State Museum at Albany. Professor Peck, in reply to a letter of inquiry regarding it, says: "My specimen of this is so poor and indistinct as to be indivisible." Later, in a conversation with Professor Peck, he expressed a very strong doubt as to the authenticity of this species. He said: "It has without doubt been described before." He did not state, however, under what species it should be placed.

III. HYPOCOPRA Fries, Summa Veg. Scand. **2**: 397. 1849; N. Am. Pyren. 133. 1892; Rabenhorst, Krypt.-Flora, **1**^{2}: 177. 1887; Cohn's Krypt.-Flora. Schleisen, **3**^{2}: 289. 1894. *Coprolepa* Fuckel, Symb. Mycol. p. 239. 1869. Saccardo, Syll. Fung. **1**: 248. 1882; **9**: 493. 1891.

Perithecia situated below a black crusty stoma with projecting, usually papilliform beaks, completely surrounded by a dense feltwork of white mycelium by which they are firmly attached to the substratum. Asci containing an apical body which colors, usually blue with iodine. Paraphyses filiform to tubular never ventricose. Spores ellipsoid, dark colored, surrounded by a prominent gelatinous envelope and containing a lateral germ slit.

Key to the Species

Spores apiculate.
- Spores very large, 24–28 $\mu \times$ 52–61 μ. — 1. *H. gigaspora.*
- Spores comparatively small, 17–20 $\mu \times$ 32–38 μ. — 2. *H. amphisphaeroides.*

Spores not apiculate.
- Stoma effused and containing an indefinite number of perithecia.
  - Perithecia sunken. — 3. *H. equorum.*
  - Perithecia half sunken. — 4. *H. fimeti.*
- Stoma with definite boundary and containing 1 to few perithecia or by confluency of individual stromas it may contain many.
  - Spores biseriate.
    - Stroma violet within. — 5. *H. violacea.*
    - Stroma white within. — 6. *H. Dakotensis.*
  - Spores uniseriate.
    - Beak papilliform.
      - Spores comparatively large, 18–24 $\mu \times$ 34–40 μ. — 7. *H. merdaria.*
      - Spores comparatively small, 6–7 $\mu \times$ 10–13 μ. — 8. *H. parvula.*
    - Beak enlarged and prominent. — 9. *H. rostrata.*

1. Hypocopra gigaspora (E. & E.)

Coprolepa gigaspora E. & E., Bull. Torr. Club, **25**: 501. 1898.

Perithecia very large, scattered or aggravated in small clusters, sunken, with the short papilliform black smooth beak irrumpent through the smooth black convex shield-shaped stroma, about .75 × 1 mm., membranaceous to coriaceous, colorless to brown and densely covered with a fine white mycelium which becomes gradually differentiated above into a true stroma.

Asci 8-spored, cylindrical, broadly rounded above and abruptly contracted below into a short triangular base, 45–52 μ × 375, × 480; apical structure very prominent and staining bright blue with iodine: paraphyses tubular to filiform, tapering upward, septate, coarsely guttulate, longer than the asci and mixed with them.

Spores obliquely uniseriate, ellipsoid to oval and broadly rounded at the ends, 24–28 μ × 52–61 μ, ranging from hyaline when young through yellow to dark brown and opaque, tipped below with a short blunt hyaline apiculum; germinal slit lateral, rather indistinct, extending nearly the entire length of the spore, surrounded by a hyaline gelatinous zone which becomes very prominent in water. (*Pl. 11. f. 12–15.*)

Distinctive character: Large size throughout and the apiculate spore.

Dry specimens: On cow dung, British Columbia, June 1897 (Macoun).

2. **Hypocopra amphisphaeroides** (E. & E.)

Sordaria amphisphaeroides E. & E., Am. Nat. **31**: 340–341. 1897; Saccardo, Syll. Fung. **14**: 492. 1899.

Perithecia scattered or aggregated in small clusters of 2–4, sunken, with a short black papilliform beak projecting through the small discoid black smooth indistinctly bounded stroma, about .75 mm. in diameter, thin, membranaceous and densely covered with a fine white mycelium which gradually changes above into the black stromatic shield.

Asci 8-spored, cylindrical, broadly rounded above and contracted below into a short blunt stipe, 24–26 μ × 240–280 μ; apical body prominent and staining intensely blue with iodine: paraphyses filiform, septate, tapering upward, coarsely guttulate, longer than the asci and mixed with them.

Spores obliquely uniseriate, ellipsoid, broadly rounded at the ends, 17–20 μ × 32–38 μ, tipped below with a small hyaline quite persistent apiculum; germ-slit marginal and extending about two-thirds the length of the spore; hyaline envelope prominent and extending greatly when placed in water. (*Pl. 11. f. 5–7.*)

Distinctive characters: Hyaline apicula of the spores and guttulate paraphyses; otherwise as *H. merdaria*.

Dry specimen: On cow dung, Rooks Co., Kan., Aug. 1896 (Bartholomew).

3. HYPOCOPRA EQUORUM (Fuckel) Wint.; Rabenhorst, Krypt.-Flora, 1^1: 178. 1887; Cohn's Krypt.-Flora. Schleisen. 3^2: 289. 1894; N. Am. Pyren. 134. *pl. 17. f. 4.* 1892.

Hypoxylon equorum Fuckel, Fungi Rheniani,* no. 1058.

Sordaria equorum (Fuckel) Wint. Abhand. d. Naturforsch. Gesel. zu Halle, **13**: 77–78. *pl.* 7. *f.* 2. 1873.

Coprolepra equorum Fuckel, Symbol. Mycol. 240. 1869.

Perithecia scattered and sunken beneath a thin black corky effuse widely spread villous stroma which often becomes smooth in age, 350–500 μ in diameter, thin, membranaceous and completely invested in a dense feltwork of white mycelium which becomes differentiated into the stroma above, subglobose, with a short black shining papilliform ostiolum which extends through the stromatic covering.

Asci 8-spored, cylindrical, broadly rounded above and contracted below into a short blunt stipe, 20–25 μ × 200–225 μ; apical apparatus of ascus staining either blue or brown with iodine: paraphyses filiform, septate, hyaline, longer than the asci and mixed with them.

Spores obliquely uniseriate, ellipsoid to slightly inequilateral, subacute to rounded, usually more acute below than above, 12–14 μ × 24–29 μ, ranging from hyaline when young through yellow to dark brown and opaque; germinal groove lateral, one-third the length of spore, surrounded by a gelatinous covering which swells greatly when placed in water. (*Pl. 11. f. 1–4 and 8–11; Pl. 19. f. 17–18.*)

Distinctive character: The thin effuse stroma.

Dry specimen: On horse dung, Hermosa, Col., March 1899 (Baker, communicated by Earle).

Cultivated specimens: On horse dung, Aberdeen, S. D., Sept. 1899 (Towne); horse and cow dung, Brookings, S. D., Nov. 1899 (Carter); horse dung, Rooks Co., Kan., Aug. 1899 (Bartholomew); horse dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

The stromatic characteristics are very variable in both American and foreign specimens. Occasionally the stroma forms a convex mass about each perithecium thereby making the whole structure appear papillate; more often the stroma is roughened only by the minute black papilliform beaks. The papillate character was very pronounced in the Colorado specimens where the perithecia were often imbedded in individual stromata as represented in the figures. Indeed, Professor Earle and myself at one time considered the Colorado specimen to be a distinct species; but

* Reference taken from literature, original not seen.

my subsequent cultures of South Dakota material appear to justify the disposition made above. The hairiness of the stroma is also a character which is variable, depending, apparently, both on the age of the specimen and also the amount of moisture in the culture. Subsequent study may necessitate a segregation of this species; but at present I can not find constant characters that warrant it.

4. HYPOCOPRA FIMETI (Pers.) Sacc. Syll. Fung. **1**: 248. 1882; Fries, Summa Veg. Scand. 397. 1849; Ellis & Everhart, N. Am. Pyren. 134. 1892.

Sordaria fimeti (Pers.) Wint. Abhand. naturforsch. Gesell. zu Halle, **13**[1]: *78–79. pl. 7. f. 3.* 1877.

Perithecia crowded or confluent, globose or ovate, 300–350 μ broad, ending above in a thick conical mostly oblique neck, and about half sunken in the thin crustaceous, effused, black, slightly wrinkled, bare stroma: asci cylindrical, short-stipitate, 140–150 $\mu \times 17 \mu$ (p. sp.), 8-spored, with filiform paraphyses: sporidia elliptic-oblong, dark brown, $18–20 \times 12 \mu$, with a gelatinous envelope.

On horse dung, New York (Peck).

This species has not been seen in any of my cultures or in any of the herbarium material at hand. It has apparently been found but once in this country.

5. **Hypocopra violacea** (E. & E.)

Sordaria violacea E. & E., Am. Nat. **31**: 340. 1897; Saccardo, Syll. Fung. **14**: 492. 1899.

Perithecia aggregated in small clusters of 2–6 and completely imbedded in the stroma or often projecting in such a way as to push the upper layer of the black rugose naked stroma into broad papillae which outline the dimensions of the perithecia; stromatic layer thick and black above, gradually decreasing in thickness and becoming fuscous or white within the substratum; within the stromatic layer the whole mass colored bright violet; the entire stroma sunken in or projecting slightly above the substratum; perithecia pyriform, about $600 \mu \times 900 \mu$, with papilliform projecting beaks. Asci obclavate, broadly rounded above, widest near the base and abruptly contracted into a short blunt stipe, rather persistent, $50–66 \mu \times 186–240 \mu$; apical structure rather small and coloring bright blue with iodine: paraphyses filiform, septate, longer than the asci and mixed with them.

Spores ellipsoid, rounded at both ends, 24–26 μ × 40–50 μ, ranging from hyaline when young through yellow to dark brown and opaque; germ slit lateral, indistinct and extending nearly the entire length of the spore; hyaline envelope prominent and extending greatly in water. (*Pl. 12. f. 1–5.*)

Distinctive character: The violet stroma.

Dry specimen: On horse dung, Rooks Co., Kan., Sept. 1896 (Bartholomew).

This species possesses considerable interest since it appears to show a transitional stage between the genus *Hypocopra* and the genus *Poronia*. In the majority of the species of *Hypocopra*, the stroma consists of a thin sheet on the surface of the substratum, while the perithecia are imbedded in a more or less dense feltwork of mycelium which decreases gradually downward; but here the whole stromatic mass in which the perithecia are imbedded is definitely bounded and consists throughout its central areas of a dense feltwork of mycelium which becomes still more condensed toward the outside where it forms a definite boundary. The whole may project slightly above the substratum. It would require but a slight development of a stalk to give the appearance of a typical *Poronia*.

6. **Hypocopra Dakotensis** sp. nov.

Perithecia sunken, scattered or aggregated in small groups of 2–4, about 600 μ × 800 μ, pyriform and clothed below by a dense growth of fine white mycelium which becomes differentiated into a smooth cushion-like circular stroma at the surface; beak papilliform, black, shining, and projecting through the stroma.

Asci 8-spored, clavate to fusiform, broadly rounded above and contracted below into a short blunt stipe, 37–40 μ × 225–265 μ, apical structure prominent and coloring bright blue with iodine, very evanescent: paraphyses filiform, septate, longer than the asci and mixed with them.

Spores biseriate, ellipsoid, rounded at both ends, 17–19 μ × 32–38 μ, ranging from hyaline when young through yellow to dark brown and opaque; germinal slit lateral and extending nearly the entire length of the spore, gelatinous envelope prominent and swelling greatly in water. (*Pl. 12. f. 6–8.*)

Distinctive character: Distinguished from *H. merdaria* by the biseriate slightly smaller spores and very evanescent asci.

Cultivated specimen: On horse dung, Aberdeen, S. D., Sept. 1899 (Towne).

7. HYPOCOPRA MERDARIA (Fries) Fries, Summa Veg. Scand. 397. 1849; Cohn's Krypt.-Flora Schlesien, **3**^{2}: 289. 1894; Rabenhorst, Krypt.-Flora, **1**^{1}: 178. 1887.

Sphaeria merdaria Fries, Elenchus Fungorum, **2**: 100. 1828.

Sordaria merdaria (Fries) Awd. Abhand. naturforsch. Gesell. zu Halle, **13**: 77. *pl.* 7. *f.* 1. 1873.

Coprolepra merdaria (Fries) Fuckel, Symb. Mycol. 240. 1869.

Perithecia scattered or aggregated in clusters of 2 to 4, sunken with a black shining small papilliform beak projecting through a disk-shaped or confluent smooth black bare flat or often slightly convex stroma, about two-thirds mm. in diameter, subglobose to pyriform, membranaceous and colorless, densely covered below the stroma with a fine colorless mycelium which ramifies through the substratum and becomes differentiated into a true stroma in its upper exposed layers.

Asci 8-spored, cylindrical, broadly rounded above and suddenly contracted below into a short blunt stipe, quite persistent, 24–32 μ × 260–320 μ; apical structure prominent and staining blue with iodine: paraphyses filiform, tapering upward, septate, longer than the asci and mixed with them.

Spores obliquely uniseriate, ellipsoid, rounded at both ends, 18–24 μ × 34–40 μ, ranging from hyaline when young through yellow to dark brown and opaque; germinal slit lateral, one-half to two-thirds the length of the spore, and indistinct at maturity; gelatinous envelope prominent and swelling greatly when placed in water. (*Pl. 12. f. 9–14.*)

Distinctive characters: Small shield-shaped scattered stromata, uniseriate and nonapiculate spores.

Dry specimens: On horse dung, Hermosa, Col., March 1899 (Baker, communicated by Earle); horse dung, Horsetooth Mountain, Oct. 1898 (Sandsten); horse and cow dung, Summit and Great Falls, Mont., Aug. 1900 (Griffiths & Lange).

Cultivated specimens: On cow dung, Highmore, S. D., Sept. 1899 (Carter); cow dung, Rooks Co., Kan., July 1899 (Bartholomew); cow dung, Biloxi, Miss., Aug. 1899 (Tracy); horse and cow dung, Summit and Family, Mont., Aug. 1900 (Griffiths & Lange); Santa Catalina Mts., Ariz., Nov. 1900.

The measurements given for this species vary considerably with those of the ordinary descriptions. This is not because the American forms are different from the European, but because the

measurements given are inaccurate. Specimens distributed by Plowright and named by Dr. Winter are at hand in which the spores measure exactly as quoted above.

The development was very profuse in both the South Dakota and the Kansas specimens—four of the samples sent me by Mr. Bartholomew having more or less of this fungus on them.

8. **Hypocopra parvula** sp. nov.

Perithecia sunken and aggregated into small clusters with small black smooth papilliform beaks extending through a black smooth crust like stroma which is definitely bounded, 300–450 μ in diameter, thin membranaceous, white below the stroma, and densely covered with fine flexuous hairs which bind the perithecia of the group firmly to each other and to the substratum.

Asci 8-spored, cylindrical, rounded above and contracted below into a long crooked stipe, 9–12 $\mu \times$ 95–105 μ, rather persistent; apical structure coloring blue with iodine: paraphyses filiform, not numerous, guttulate, sparingly and indistinctly septate, slightly longer than the asci and mixed with them.

Spores obliquely uniseriate, ellipsoid, rounded at both ends but often more acutely so below, 10–13 $\mu \times$ 6–7 μ; gelatinous covering swelling moderately in water; germinal slit lateral and extending nearly the entire length of the spore. (*Pl. 19. f. 7–9.*)

Distinctive character: Small size throughout but more especially of the spores.

Cultivated specimens: On cow dung, Summit, Mont., Aug. 1900 (Griffiths & Lange).

9. **Hypocopra rostrata** sp. nov.

Perithecia sunken, aggregated in small clusters in a dense feltwork of white to light brown mycelium which scarcely assumes the character of a true stroma, subglobose to oval, 300–400 μ in diameter, colorless below and densely covered with a fine white mycelium which becomes but slightly condensed toward the surface; beak black, shining, prominent, hood-like and projecting through the pseudostroma.

Asci 8-spored, cylindrical, rounded above and contracted below into a short stipitate base, 21 $\mu \times$ 213–286 μ; apical structure prominent and coloring bright blue with iodine: paraphyses filiform, septate, longer than the asci and mixed with them.

Spores obliquely monoseriate, ellipsoid, rounded at both ends, 13–18 $\mu \times$ 29–32 μ, ranging from hyaline when young through yellow to dark brown and opaque; germimal slit lateral, promi-

nent, about one-half the length of the spore, covered by a hyaline envelope which swells greatly in water. (*Pl. 12. f. 15–18.*)

Distinctive character: The prominent beak and pseudostroma.

Cultivated specimen: On horse dung, Tucson, Arizona, Jan. 1900 (Tyler); on horse dung, Tucson, Ariz., Sept. 1900.

IV. DELITSCHIA Auerswald, Hedwigia, **5**: 48. 1866; Rabenhorst, Krypt.-Flora, **1**^{2}: 179. 1887; Saccardo, Syll. Fung. **1**: 732. 1882; Cohn's Krypt.-Flora Schlesien, **3**^{2}: 289. 1894.

Perithecia superficial or sunken, thin and membranaceous to thick and coriaceous, dark brown to black and opaque, hairy or smooth. Asci 8- to 16-spored with an internal membrane which generally ruptures on a plainly marked constriction just below the apex. Spores 2-celled, dark brown and opaque, usually with a gelatinous envelope.

Key to the Species

Asci 8-spored.	
Spores obliquely septate.	
Spores uniseriate.	
Spores deeply constricted.	1. *D. didyma.*
Spores with broad shallow constriction.	2. *D. eccentrica.*
Spores biseriate.	3. *D. leporina.*
Spores transversely septate.	
Spores with hyaline envelope.	
Beak papilliform or short cylindrical.	
Spores small, 5–6 $\mu \times$ 10–11 μ.	4. *D. Marshalii.*
Spores large, 13–16 $\mu \times$ 42–54 μ.	5. *D. furfuracea.*
Beak long cylindrical or tuberculiform.	
Spores large, 25–27 $\mu \times$ 54–72 μ.	6. *D. Winteri.*
Spores comparatively small, 13–16 $\mu \times$ 27–30 μ.	7. *D. vulgaris.*
Spores without hyaline envelope but having a hyaline apiculum.	8. *D. apiculata.*
Asci 16-spored.	9. *D. polyspora.*

1. DELITSCHIA DIDYMA Awd. Hedwigia, **5**: 49. 1866; Hedwigia, **7**: 72. *pl. 1. f. 9.* 1868

Delitschia Auerswaldii Fuckel, Symb. Mycol. p. 241. 1869; Sacc. Syll. Fung. **1**: 732. 1882; Rabh. Krypt.-Flora, **1**^{1}: 172. 1882; Cohn's Krypt.-Flora v. Schlesien, **3**^{2}: 290. 1894.

Perithecia sunken, scattered, with papilliform or long cylindrical curved or twisted black beak which may be uniformly covered with short brown septate hairs or perfectly smooth, black and bare, 400 μ–700 μ in diameter, subglobose to pyriform, thin membranaceous, dark brown to black and opaque.

Asci 8-spored, cylindrical to very slightly clavate, broadly rounded above and contracted below into a rather long tapering stipe, 28–32 μ × 225–260 μ, rather persistent: paraphyses filiform, septate, abundant, longer than the asci and mixed with them.

Spores obliquely uniseriate, ellipsoid, acutely rounded at the ends, obliquely uniseptate with a narrow deep constriction, 15–18 μ × 42–46 μ, ranging from hyaline when young through yellow to dark brown and opaque, gelatinous envelope prominent and swelling greatly in water. (*Pl. 13. f. 4–6.*)

Distinctive character: Uniseriate deeply constricted and obliquely septate spores.

Cultivated specimens: On cow dung, New York City, Aug. 1899; cow dung, Highmore, S. D., Sept. 1899 (Carter).

While the perithecia in the South Dakota specimens were much more numerous than in the others they were still very scattering and few in number. I judge that the species seldom occurs very plentifully although it appears to be widely distributed.

2. **Delitschia eccentrica** sp. nov

Perithecia scattered, sunken, with a long projecting cylindrical truncate or rounded beak which is usually covered with short septate brown hairs up to the enlarged bare black smooth or warty apex, .75 mm. × .30–.50 mm., thin membranaceous, dark brown to black and opaque.

Asci 8-spored, cylindrical, broadly rounded above and contracted below into a moderately stout stipe, quite persistent, 34–40 μ × 330–370 μ: paraphyses filiform, sparingly and indistinctly septate, longer than the asci and mixed with them.

Spores ellipsoid, acutely rounded at both of the excentric ends, obliquely uniseptate with a broad very shallow constriction, 21–24 μ × 45–50 μ, ranging from hyaline when young through yellow to dark brown and opaque; hyaline covering extending greatly in water. (*Pl. 13. f. 7–9.*)

Distinctive characters: Beak of perithecium and obliquely septate and narrowly constricted spores.

Cultivated specimens: On cow dung, Austin, Texas, Jan. 1900, (Long); cow dung, Biloxi, Miss., Sept. 1899 (Tracy).

3. **Delitschia leporina** sp. nov.

Perithecia scattered, sunken with projecting, black, broad truncate, roughened or warty beak which is uniformly covered with long, flexuous, delicate, brown, septate hairs, about 500 μ × 600–750 μ, pyriform to short cylindrical or conical truncate, thin, membranaceous, dark brown to black and opaque.

Asci 8-spored, clavate, broadly rounded above and contracted below into a short blunt stipe, 30–34 μ × 240–295 μ, persistent: paraphyses filiform, septate, abundant, mixed with and longer than the asci.

Spores biseriate, rather narrowly ellipsoid, acutely rounded at the ends, obliquely uniseptate with a deep, rather broad constriction, 16–20 μ × 40 – 65, ranging from hyaline when young through yellow to dark brown and opaque, hyaline envelope very distinct and evidently septate, corresponding to the septum of the spore, when swollen by the action of water. (*Pl. 13. f. 14–16.*)

Distinctive characters: Biseriate, obliquely and deeply constricted spores.

Cultivated specimens: On rabbit dung, Ft. Lee, N. J., Nov. 1899.

4. DELITSCHIA MARSHALII Berl. et Vogl.; Saccardo, Syll. Fung. Add. **1–4**: 127. 1886; **9**: 747. 1891

Delitschia sp. Bull. Soc. Royale Bot. Belg. **23**[2]: 16, and **23**[1]: 199. 1884.

Perithecia scattered, sunken, subglobose, 275–350 μ in diameter,. thin, membranaceous, black and opaque, with a black papilliform beak.

Asci 8-spored, cylindrical, broadly rounded above and slightly contracted below into a short stout stipe, 9–12 μ × 65–80 μ: paraphyses filiform, sparingly branched, indistinctly septate, numerous, mixed with the asci and about equal to them in length.

Spores obliquely uniseriate, ellipsoid to oval, two-celled, but little if at all constricted, 5–6 μ × 10–11 μ, ranging from hyaline when young through yellow to dark brown and opaque, surrounded by a very narrow hyaline gelatinous envelope. (*Pl. 13. f. 1–3.*)

Distinctive character: Small size throughout.

Dry specimen: On rabbit dung, Newfield, N. J., June 1884 (Ellis).

Cultivated specimens: On sheep dung, Brookings, S. D., Nov. 1899 (Carter); rabbit dung, Gunnison, Colo., Aug. 1899 (Bartholomew); rabbit dung, London, Ont., Aug. 1898 (Dearness); rabbit dung, Tucson, Arizona, Sept. 1900.

5. DELITSCHIA FURFURACEA Niessl, Hedwigia, **23**: 75. 1884; Rehm, Ascomyceten, no. 747; Saccardo, Syll. Fung. Add. **1–4**: 127. 1886; **9**: 747. 1891; Rabenhorst, Krypt.-Flora, **1**[1]: 180. 1887.

Perithecia scattered, sunken, with projecting black bare papilliform or short cylindrical beak, 450 μ × 650 μ in diameter, subglobose to pyriform, membranaceous to slightly coriaceous, dark brown to black, and at first having a distinctively greenish tint on the substratum around the base of the beak.

Asci 8-spored, clavate to fusiform, usually widest below the middle, broadly rounded above and rather abruptly contracted below into a short blunt stipe, 40–48 μ × 250–300 μ: paraphyses filiform, coarsely guttulate, septate, longer than the asci and mixed with them.

Spores somewhat biseriate below, oval to ellipsoid, broadly or acutely rounded at the ends, uniseptate with a broad shallow constriction, 18–24 μ × 42–54 μ: ranging from hyaline when young through yellow to dark brown and opaque; gelatinous envelope prominent and enlarging greatly in water. (*Pl. 14. f. 7–9.*)

Distinctive character: Papilliform beak and greenish coloration.

Dry specimen: On rabbit dung, Rooks Co., Kan., Sept. 1895 (Bartholomew).

Cultivated specimens: On rabbit dung, Rooks Co., Kan., July 1899 (Bartholomew); horse dung, Missoula, Mont., Jan. 1900 (Elrod); burro dung, Hermosa, Colo., March 1898 (Baker, communicated by Earle).

6. DELITSCHIA WINTERI Plowr. Grevillea, **2**: 188. *pl. 25. f. 1.* 1874; Saccardo, Syll. Fung. **1**: 734. 1882

Perithecia scattered, sunken, pyriform to globular, with long wide cylindrical curved or twisted projecting beak which may be sparingly covered with long straight brown hair, or entirely smooth, black and shiny, about .75 mm. × 1 mm., thick membranaceous to decidedly coriaceous, dark brown to black and opaque.

Asci 8-spored, cylindrical-clavate, broadly rounded above and contracted below into a moderate stipe, 48–56 μ × 300–375 μ, rather persistent: paraphyses filiform, sparingly septate and slightly constricted below, abundant, longer than the asci and mixed with them.

Spores biseriate, elliptical to ovate, broadly to acutely rounded at the ends, uniseptate with a broad shallow constriction, 25–27 μ × 54–72 μ, ranging from hyaline when young through yellow to dark brown and opaque; hyaline envelope prominent and becoming very wide in water. (*Pl. 14. f. 10–12.*)

Distinctive characters: Long cylindrical beak; distinguished from *D. furfuracea* by larger size throughout.

Cultivated specimens: On horse and cow dung, Austin, Texas, Jan. 1900 (Long); cow dung, Englewood, N. J., July 1899; cow dung, Proctor, Vt., Aug. 1899 (Banker); horse dung, Aberdeen, S. D., Sept. 1899 (Towne); cow dung, Rooks Co., Kan., July 1899 (Bartholomew); cow and horse dung, Tucson, Ariz., Jan. 1900 (Tyler); cow dung, Biloxi, Miss., Aug. 1899 (Tracy); horse dung, Missoula, Mont., Jan. 1900 (Elrod); horse dung, Brookings, S. D., Nov. 1899 (Carter); cow dung, Kingston, R. I., Dec. 1899 (Underwood); horse dung, Great Falls, and Summit, Mont., Aug., 1900 (Griffith & Lange); cow dung, Family, Mont., Aug. 1900.

7. **Delitschia vulgaris** sp. nov.

Perithecia scattered, sunken, subglobose to pyriform with a long cylindrical curved or twisted beak which is densely covered with short wavy brown sparingly septate hairs, 375–450 μ × 600–750 μ, thin membranaceous, brown to black and opaque.

Asci 8-spored, cylindrical, broadly rounded above and contracted below into a stout tapering stipe, persistent, 24–27 μ × 185–215 μ: paraphyses filiform, septate, abundant, longer than the asci and mixed with them.

Spores obliquely uniseriate, two-celled, broadly rounded at the ends, constriction broad and shallow, 13–16 μ × 27–30 μ, ranging from hyaline when young through yellow to dark brown and opaque; hyaline envelope prominent and swelling greatly in water. (*Pl. 14. f. 4–6.*)

Distinctive characters: Long hairy beak and oval spores.

Cultivated specimens: Frequent on horse and cow dung, New York city and Ft. Lee, N. J., summer and autumn, 1899; cow dung, Auburn, Ala., Aug. 1899 (Earle).

Although this species was found on at least a dozen cultures from the localities quoted, it was always found in very small quantities. Often but two or three perithecia, and never over a dozen have been found in the same culture.

8. **Delitschia apiculata** sp. nov.

Perithecia half sunken, scattered or aggregated in small clusters, 300–350 μ × 375–500 μ, thin membranaceous, pyriform with papilliform to short cylindrical curved black beak which is sparingly covered with short straight acuminate brown uniseptate bristly hairs.

Asci 8-spored, clavate, broadly rounded above and contracted below into a long tapering stipe, very evanescent, 32–38 μ × 160–

200 μ: paraphyses filiform, abundant, indistinctly septate, much longer than the asci, and mixed with them.

Spores biseriate, ellipsoid, sharply rounded at the ends, two-celled, not constricted at the septum, 16–21 μ × 28–34 μ; hyaline envelope entirely absent, but the spore is tipped at each end with a short hyaline triangular apiculum. (*Pl. 13. f. 10–13.*)

Distinctive characters: Hyaline apicula of the spores.

Cultivated specimen: On dead stems of Russian thistle, Aberdeen, S. D., March 1898.

The species is not to be considered even semiparasitic. The stems of *Salsola Kali tragus* were collected in a rubbish heap where they were found infected with some other pyrenomycetous fungus. These were placed in a moist chamber in March 1899 and kept in a moist condition until the first of June. Some time in the latter part of May, the mature perithecia of this fungus were found in considerable numbers.

The septa of the spores do not appear as early as in the majority of the species of the genus. The illustration of the ascus was made when the spores were in the yellow condition, yet they showed no signs of the septa which are visible in other species before the spores have left the hyaline state.

9. **Delitschia polyspora** sp. nov.

Perithecia scattered, sunken, with a projecting truncate black bare shining cylindrical straight or curved beak of variable length, about .65–.75 mm. × 1 mm., subglobose to pyriform, slightly coriaceous, dark brown to black and opaque.

Asci 16-spored, clavate to fusiform, broadly rounded above and rather abruptly contacted below into a short blunt stipe, 85–100 μ × 340–375 μ, rather persistent: paraphyses filiform, septate, abundant, longer than the asci, and mixed with them.

Spores triseriate to crowded, ellipsoid, usually broadly rounded at the ends, uniseptate with a broad deep constriction, 21–24 μ × 52–62 μ, ranging from hyaline when young through yellow to dark brown and opaque; hyaline envelope prominent and having an evident septum which may be distinctly seen when extended in water corresponding to that of the spore. (*Pl. 14. f. 1–3.*)

Distinctive characters: Large size throughout and many-spored ascus.

Cultivated specimen: On cow dung, Tucson, Ariz., Jan. 1900 (Tyler).

V. SPORORMIA DeNotaris, Microm. Italici novi vel minus cogniti, Dec. V. No. 6. 1845; Rabenhorst, Krypt.-Flora, $\mathbf{1}^2$: 180. 1887; N. Am. Pyren. 134. 1892; Cohn, Krypt.-Flora Schlesien, $\mathbf{3}^2$: 290. 1894; Saccardo, Syll. Fung. **2**: 123; **9**: 816; **11**: 329; **14**: 577.

Homospora DeNot; Fries, Summa Veg. Scand. **2**: 404. 1849.

Perithecia globular or oval, sunken or less frequently superficial with papilliform to cylindrical beak, membranaceous to coriaceous and sometimes slightly brittle. Asci cylindrical to clavate with an internal membrane which is usually perforate at the apex. Spores cylindrical, 4 to many-celled, usually dark brown and opaque and surrounded by a gelatinous covering.

Key to the Species

Spores 4-celled	
Beak always small, papilliform or wanting.	
Paraphyses few or entirely wanting.	
Spores dark brown or black at maturity.	1. *S. minima.*
Spores yellow at maturity.	2. *S. chrysopora.*
Paraphyses abundant.	
Spores narrowly cylindrical.	
Asci clavate: spores 9–11 $\mu \times$ 48–60 μ.	3. *S. intermedia.*
Asci cylindrical: spores 5–6 $\mu \times$ 32–35 μ.	4. *S. leporina.*
Spores oval to broadly cylindrical.	5. *S. lata.*
Beak prominent: papilliform to short cylindrical.	
Spores uniseriate, small.	6. *S. pulchella.*
Spores biseriate, large.	7. *S. megalospora.*
Beak long cylindrical or enlarged and tubercular.	
Beak tubercular.	
Plant small: spores 5.5–7 $\mu \times$ 32–33 μ.	8. *S. tuberculata.*
Plant large: spores 10–12 $\mu \times$ 72–77 μ.	9. *S. Kansensis.*
Beak cylindrical.	
Beak hairy.	10. *S. chaetomioides.*
Beak smooth, long and narrow.	11. *S. Dakotensis.*
Spores more than 4-celled.	
Spores 7-celled.	12. *S. Americana.*
Spores 8-celled.	13. *S. corynespora.*
Spores 16-celled, united into a cylindrical mass.	14. *S. fimetaria.*
Spores 11–16-celled with a very large cell in upper spore of ascus.	15. *S. herculea.*

1. SPORORMIA MINIMA Awd. Hedwigia, **7**: 66. 1868; Nuova Gior. Bot. Ital. **10**: 151. 1878; Saccardo, Syll. Fung. **2**: 124. 1883; N. Am. Pyren. 134. *pl. 18. f. 6–9.* 1892; Cohn's Krypt.-Flora, $\mathbf{3}^2$: 291. 1894; Rabenhorst, Krypt.-Flora, $\mathbf{1}^2$: 181. 1887; Berlese, Icones Fung. *pl. 28. f. 4.* 1894.

Sphaeria multifera B. & Rav. Grevillea, **4**: 143. 1876.

Philocopra multifera (B. & Rav.) Sacc. Syll. Fung. **1**: 249; Ellis & Everhart, N. Am. Pyren. 133. 1892.

Perithecia scattered, sunken, with the small papilliform beak projecting to the surface, later they are more or less erumpent and the beak disappears almost entirely, leaving the perithecium simply perforate, 90–120 μ in diameter, globular, thin, membranaceous, dark brown and opaque.

Asci 8-spored, cylindrical-clavate, broadly rounded above and contracted below into a short or almost sessile base, rather persistent, 13–17 $\mu \times$ 65–95 μ: paraphyses very scanty or often entirely absent, filiform, septate, about equal to the asci.

Spores in 2 or 3 series, 4-celled, straight or curved, cylindrical, rounded at the ends, deeply constricted and easily separable, 5.5–6 $\mu \times$ 29–34 μ, ranging from hyaline when young through yellow to dark brown and opaque; hyaline envelope becoming very prominent in water and evidently septate, corresponding with the septation of the spore. (*Pl. 15. f. 16–18.*)

Distinctive characters: Small size and few paraphyses.

Dry specimens: On goat, cow, and rabbit dung, Newfield, N. J., 1880–93 (Ellis); rabbit, horse, and cow dung, Michigan Agricultural College, 1893 (Hicks); cow dung, London, Ont., 1897 (Dearness).

Cultivated specimens: On goat, cow, and horse dung, New York city and Fort Lee, N. J., summer and autumn 1899; cow dung, Proctor, Vt., Aug. 1899 (Banker); cow dung, Aberdeen, S. D., Sept. 1899 (Towne); horse, cow, and prairie-dog dung, Highmore, S. D., July 1899 (Carter); horse and cow dung, Redfield, S. D., July 1899 (Carter); horse and cow dung, Brookings, S. D., Nov. 1899 (Carter); horse dung, Gunnison, Col., Aug. 1899 (Bartholomew); burro dung, Hermosa, Col., March 1898 (Baker, communicated by Earle); horse, cow, and rabbit dung, Mesilla Park, N. M., Jan. 1900 (Wooton); sheep, cow, horse, rabbit, and dog dung, Tucson, Ariz., Jan. 1900 (Tyler); horse dung, Sept. 1900 (Griffiths); cow dung, Rooks Co., Kan., July 1899 (Bartholomew); horse, goat, and sheep dung, Austin, Tex., Jan. 1900 (Long); cow dung, London, Ont., Aug. 1899 (Dearness); cow dung, De Soto, La., Aug. 1899 (Frierson); horse and cow dung, Summit and Family, Mont., Aug. 1900 (Griffiths & Lange).

The reduction to synonymy of *Sphaeria multifera* B. & Rav. may deserve a word of explanation, since it seems almost incredible that a species of *Sporormia* should be mistaken by anyone for a species of *Pleurage*, as has been done repeatedly in our literature. That this mistake was made, however, is the opinion of two besides myself. Mr. Ernest Salmon sent me very careful drawings of the original of *Sphaeria multifera* B. & Rav., collected by Dr. Michener in Pennsylvania. Later he has had the kindness to send me a fragment of the type together with the additional information that M. C. Cooke has at some time written opposite no. 913 in the copy of Sacc. Syll. Fung. in the Kew herbarium: "(*Philocopra multifera*) = *Sporormia minima*." The portion of the type at hand certainly contains nothing but *Sporormia minima*. The original description was doubtless written upon hasty examination of material in which the individual cells of the spores had separated.

2. **Sporormia chrysospora** sp. nov.

Perithecia scattered, sunken, or aggregated in small clusters and irrumpent, becoming more or less free at maturity, globular with a short black bare papilliform beak, or the beak may be entirely absent when the ostiolum is simple, perforate, 225–300 μ in diameter, thin membranaceous or often inclined to be brittle, black and opaque.

Asci 8-spored, cylindrical-clavate, broadly rounded above and contracted below into a short blunt stipe persistent, 10–12 $\mu \times$ 65–95 μ: paraphyses filiform, septate, scanty, mixed with the asci and about equal to them in length.

Spores biseriate, narrowly ellipsoid, slightly wider above than below, rounded at the ends, 5–7 $\mu \times$ 21–24 μ, 4-celled with shallow constrictions, not easily separable, light yellow when mature; hyaline covering narrow and often indistinct. (*Pl. 15. f. 4–6.*)

Distinctive character: Yellow spores.

Dry specimen: On rabbit dung, Decorah, Iowa, July 1899 (Holway).

3. SPORORMIA INTERMEDIA Awd. Hedwigia, **7**: 67. *pl. 1. f. 4.* 1868; Berlese, Icones Fung. **1**: *pl. 29. f. 2.* 1894; Rabenhorst, Krypt.-Flora, $\mathbf{1}^2$: 182. 1887; N. Am. Pyren. 135. 1892; Saccardo, Syll. Fung. **2**: 126. 1883; Cohn's Krypt.-Flora, $\mathbf{3}^2$: 292. 1894; Nuova Gior. Bot. Ital. **10**: 149. 1878.

Perithecia sunken and scattered, or more often aggregated into small clusters and erumpent by pushing up small areas of the substratum which fall away and leave the small clusters of perithecia exposed, subglobose with small black shining papilliform beak, 175–225 μ in diameter, coriaceous or often slightly brittle, always perfectly black and opaque when mature.

Asci 8-spored, clavate, broadly rounded above and contracted below into a short blunt usually curved base, 24–28 μ × 170–200 μ, quite persistent, opening by a lid-like or a thimble-like rupture when the perforate membrane becomes plainly visible : paraphyses filiform, septate and constricted below, sparingly branched, longer than the asci and mixed with them.

Spores in 2–3 series and overlapping, 4-celled, deeply constricted, cylindrical, straight or slightly curved, broadly rounded at the ends, 9–11 μ × 48–60 μ ; hyaline envelope surrounding the entire spore, swelling greatly in water where it shows striations continuous with the septa of the spore. (*Pl. 15. f. 19–21.*)

Distinctive characters : Globular perithecia, clavate asci and comparatively broad spores.

Dry specimens : On rabbit dung, Newfield, N. J., Jan. 1884 (Ellis) ; rabbit dung, Bruice Point, Ontario, Aug. 1898 (Dearness).

Cultivated specimens : On rabbit dung, Ft. Lee, N. J., Oct. 1899 ; rabbit dung, Gunnison, Colo., Aug. 1899 (Bartholomew) ; horse dung, New York City, Oct. 1899 ; cow dung, Aberdeen, S. D., Sept. 1899 (Towne) ; cow and prairie-dog dung, Highmore, S. D., Sept. 1899 (Carter) ; sheep and cow dung, Brookings, S. D., Nov. 1899 (Carter) ; rabbit dung, Tucson, Ariz., Jan. 1900 (Tyler) ; cow dung, Proctor, Vt., Aug. 1899 (Banker) ; horse dung, Summit, Mont., Aug. 1900 (Griffiths & Lange) ; rabbit and cow dung, Rooks Co., Kan., July 1899 (Bartholomew) ; rabbit dung, Austin, Tex., Jan. 1900 (Long) ; cow dung, Biloxi, Miss., Sept. 1899 (Tracy) ; cow dung, London, Ontario, Aug. 1899 (Dearness) ; dog dung, Missoula, Mont., Jan. 1900 (Elrod) ; horse dung, Tucson, Ariz., Sept. 1900.

4. SPORORMIA LEPORINA Niessl, Oest. Bot. Zeitschrift, 19. 1878*; Hedwigia, **17** : 147. 1878 ; Saccardo, Syll. Fung. **2** : 124. 1883 ; Berlese, Icones Fung. **1** : *pl. 28. f. 3.* 1894 ; Rabenhorst, Krypt.-Flora, $\mathbf{1}^2$: 181. 1887 ; Cohn's Krypt.-Flora Schlesien $\mathbf{3}^2$: 291. 1894.

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* This paper has not been seen.

Perithecia sunken and scattered or aggregated in small loose clusters which become erumpent and from small elevations of the material of the substratum, which, on disintegrating, leaves the perithecia exposed, 150–180 μ × 200–225 μ, subglobose to ovate papilliform or conical beak, thin membranaceous or often inclined to be brittle black and shining above.

Asci 8-spored, cylindrical, broadly rounded above and contracted below into a short blunt stipe, persistent, 12–16 μ × 105–135 μ: paraphyses filiform, septate, constricted especially below, sparingly branched, abundant, longer than the asci and mixed with them.

Spores obliquely biseriate, cylindrical, 4-celled, deeply constricted, easily separable, rounded at the ends, 5–6 μ × 32–35 μ, ranging from hyaline when young through yellow to dark brown and opaque; hyaline envelope becoming prominent in water and evidently striated corresponding with the septation of the spores. (*Pl. 15. f. 22–24.*)

Cultivated specimens: On horse and cow dung, New York City, Oct. 1899; rabbit dung, Ft. Lee, N, J., Nov. 1899; rabbit dung, Bronx Park, N. Y., Jan. 1900 (Wilson); rabbit dung, Gunnison, Col., Aug. 1899 (Bartholomew); rabbit dung, London, Ont., Aug. 1898 (Dearness); rabbit dung, Tucson, Ariz., Jan. 1900 (Tyler); rabbit dung, Austin, Texas, Jan. 1900 (Long); rabbit dung, Mesilla Park, N. M., Jan. 1900 (Wooton); rabbit dung, Lincoln Co., N. M., Aug. 1900 (Earle); horse dung, Great Falls, Mont., Aug. 1900.

The description of the perithecium as given above applies especially to the species as grown in culture chambers on rabbit dung. On other substrata the habit of growth would be slightly different; in a dense substratum such as cow dung the perithecia almost always remain sunken.

5. **Sporormia lata** sp. nov.

Perithecia scattered, sunken and firmly attached to the substratum by an abundance of fine white rhizoids, about 375 × 600 μ, subglobose to ovate with a short papilliform bare black and shining beak, membranaceous to coriaceous, black and opaque.

Asci 8-spored, cylindrical, broadly rounded above and narrowed below into a short stout blunt stipe, persistent, 30–35 μ × 260–320 μ: paraphyses filiform, septate, richly branched, very numerous, slightly longer than the asci and mixed with them.

Spores uniseriate, oval to broadly cylindrical, broadly rounded

at the ends, 16–18 $\mu \times$ 45–48 μ, 4-celled, deeply constricted but not easily separable; hyaline covering prominent and swelling greatly in water. (*Pl. 16. f. 10–12.*)

Distinctive characters: Oval to broadly cylindrical, uniseriate spores.

Dry specimens: On rabbit dung, Decorah, Iowa, July 1899 (Holway).

6. SPORORMIA PULCHELLA Hansen. Naturhist. Forening. Kjoben. Vidensk. Middel. for Aarene, 320–321. *pl. 9. f. 23–25.* 1876; Sacc. Syll. Fung. **2**: 123. 1883; Nuovo Gior. Bot. Ital. **10**: 145. 1878; Rabenhorst, Krypt.-Flora, **1**^{2}: 181. 1887.

Perithecia scattered, sunken, erumpent and more or less superficial at maturity, globular, with a papilliform to short cylindrical black naked curved or straight beak which may be lighter colored at the very apex, including beak, 180–300 $\mu \times$ 300–450 μ, thin membranaceous, black and opaque.

Asci 8-spored, cylindrical, broadly rounded at the apex and slightly contracted below into a short comparatively wide blunt stipe, persistent, 10–13 $\mu \times$ 133–181 μ: paraphyses filiform, septate, branched, mixed with the asci and about equaling them in length.

Spores obliquely uniseriate, narrowly ellipsoid, acutely rounded at the ends, 5–8 $\mu \times$ 23–24 μ, 4-celled, deeply constricted but not easily separable, dark brown and opaque, surrounded by a prominent hyaline covering. (*Pl. 15. f. 10–12*).

Distinctive character: Uniseriate spores.

Cultivated specimen: On cow dung, Highmore, S. D., Sept. 1899 (Carter).

7. SPORORMIA MEGALOSPORA Awd. Hedwigia, **7**: 68. *pl. 1. f. 5.* 1868; Berlese, Icones Fung. **1**: *pl. 29. f. 5.* 1894; Cohn's Krypt.-Flora, **3**^{2}: 292. 1894; Rabenhorst, Krypt.-Flora, **1**^{2}: 183. 1887; Nuovo Gior. Bot. Ital. **10**: 151. 1878; Saccardo, Syll. Fung. **2**: 126. 1883.

Perithecia scattered, sunken, but erumpent and more or less exposed at maturity, globular with a papilliform or short cylindrical bare black and shining beak, 300–400 μ in diameter, slightly coriaceous, black and opaque.

Asci cylindrical, clavate, broadly rounded above and contracted below into a comparatively broad stout base, persistent, 35–45 $\mu \times$ 180–250 μ: paraphyses filiform, septate, sparingly branched, abundant, longer than the asci and mixed with them.

Spores in 2 or 3 series, cylindrical, broadly to acutely rounded at the ends, 4-celled, deeply constricted and easily separable, $70–85\,\mu \times 15–18\,\mu$, ranging from hyaline when young through yellow to dark brown and opaque; hyaline gelatinous covering rather narrow and swelling but little in water. (*Pl. 16. f. 1–3.*)

Distinctive characters: Large 4-celled spores and large globular perithecia.

Cultivated specimens: On cow dung, New York City, Aug. 1899; cow dung, Englewood, N. J., Sept. 1899; horse dung, Aberdeen, S. D., Sept. 1899 (Towne); rabbit and cow dung, Rooks Co., Kan., July 1899 (Bartholomew); cow dung, Highmore, S. D., Sept. 1899 (Carter); cow and horse dung, Brookings, S. D., Nov. 1899 (Carter); cow dung, Kingston, R. I., Dec. 1899; (Underwood); cow dung, Tucson, Ariz., Jan. 1900 (Tyler); cow dung, Auburn, Ala., Aug. 1899 (Earle); rabbit dung, Tucson, Ariz., Sept. 1900; cow dung, Summit, Family and Great Falls, Mont., Aug. 1900 (Griffith & Lange); rabbit dung, Lincoln Co., N. M., Aug. 1900 (Earle); cow dung, Tucson, Ariz., Nov. 1900.

The Arizona specimens have spores much more variable than any of the others. They often measure as high as $105\,\mu$ in length, thus equalling *Sporormia gigantea* Hansen in size. As there are, however, plenty of spores which appear to be normal in size, it seems better not to attempt a separation of the species at present.

8. **Sporormia tuberculata** sp. nov.

Perithecia scattered, sunken and remaining so at maturity, globular to ovate with a long projecting funnel form to irregularly tubercular enlarged black beak, $225–275\,\mu \times 375–450\,\mu$, thin membranaceous, black and opaque.

Asci 8-spored, clavate, broadly rounded above and contracted below into a rather long narrow stipe, persistent, $11–13\,\mu \times 100–130\,\mu$: paraphyses filiform, faintly septate, guttulate, mixed with the asci and about equal to them in length.

Spores biseriate, cylindrical, rounded at the ends, 4-celled, deeply constricted and easily separable, $5.5–7\,\mu \times 32–33\,\mu$; gelatinous envelope rather narrow. (*Pl. 15. f. 13–15.*)

Distinctive character: The peculiar beak.

Cultivated specimens: On goat dung, Ft. Lee, N. J., Jan. 1900; horse dung, Tucson, Ariz., Jan. 1900 (Tyler).

The Arizona specimens have rather simpler beaks to the perithecia than the others, but even here they are conspicuously enlarged at the apex.

The species is smaller throughout than either *Sporormia ambigua* or *S. lageniforme* to which it is closely related. It can readily be distinguished from *S. minima* by the beak of the perithecium and the stipe of the ascus.

9. **Sporormia Kansensis** sp. nov.

Perithecia scattered, sunken, erumpent, and partly exposed at maturity, globular with a long wide black bare cylindrical or funnelform tuberculate beak, 300–450 μ × 600–900 μ, firmly attached to substratum by numerous fine rhizoids: rather thick, coriacious, black and opaque.

Asci cylindrical, broadly rounded above and contracted below into a moderately stout stipe, persistent, 26–34 μ × 240–290 μ: paraphyses filiform, septate, homogeneous, abundant, sparingly branched, longer than the asci and mixed with them.

Spores in 2 or 3 series, cylindrical, straight or slightly curved, rounded at the ends, very deeply constricted and easily separable, 4-celled, 10–12 μ × 72–77 μ, ranging from hyaline when young through yellow to dark brown and opaque; hyaline covering prominent and stretching greatly in water. (*Pl. 16. f. 7–9.*)

Distinctive characters: Long cylindrical tuberculate beak of perithecium and long comparatively narrow spores.

Cultivated specimen: On rabbit dung, Rooks Co., Kan., July 1899 (Bartholomew).

10. **Sporormia chaetomioides** sp. nov.

Perithecia scattered, sunken with a long cylindrical straight or curved beak which is densely covered with long flexuous faintly septate fuscous to brown hairs as far as the black shining apex, which appears, when viewed from above, as a black perforate speck surrounded by the long wavy hairs, 300–400 μ × 600–700 μ, thin membranaceous, greenish below when young, but finally black and opaque.

Asci 8-spored, cylindrical-clavate, broadly rounded above and contracted below into a long slender stipe about half the length of the spore-bearing portion, rather persistent, 13–18 μ × 130–180 μ: paraphyses abundant, filiform, septate, branching, much longer than the asci and mixed with them.

Spores in two or three series, cylindrical, broadly to acutely rounded at the ends, 5–6 μ × 26–40 μ, 4-celled, deeply con-

stricted and easily separable, brown and opaque when mature; hyaline covering rather narrow. (*Pl. 16. f. 7–9.*)

Distinctive character: Long hairy beak of perithecium.

Cultivated specimens: On cow dung, Biloxi, Miss., Sept. 1899 (Tracy); cow dung, Tucson, Ariz., June 1900 (Tyler).

There is considerable difference in spore measurements in the specimens from Mississippi and Arizona. In the former they measure 26–30 μ in length while in the latter they are 28–40 μ long. There is no other difference.

The species is one of the most difficult of the genus to secure measurements of the asci. Even after treatment with iodized potassium iodide for a considerable period before rupturing the perithecium, many of the asci elongate in apparently a normal manner. This may occur even in the olive green state of the spores, and when the epiplasm of the ascus is deeply stained by the iodine.

11. **Sporormia Dakotensis** sp. nov.

Perithecia scattered or aggregated in small clusters, sunken, globular with a long projecting narrowly cylindrical curved straight or variously contorted bare black beak, 350–450 μ × 700–800 μ, thin membranaceous, finally becoming black and opaque.

Asci 8-spored, clavate, rounded above and contracted below into a long slender stipe, 8–11 μ × 90–110 μ: paraphyses filiform, abundant, septate, longer than the asci and mixed with them.

Spores in 2 or 3 series, cylindrical, straight or curved, rounded at the ends, 3–4 μ × 22–24 μ, 4-spored, deeply constricted and easily separable, hyaline covering narrow and often indistinct. (*Pl. 15. f. 7–9.*)

Distinctive characters: Long slender beak and small spores.

Cultivated specimens: On horse dung, Brookings, S. D., Nov. 1899 (Carter); cow dung, Biloxi, Miss., Sept. 1899 (Tracy); Great Falls, Mont., Aug. 1900 (Griffiths & Lange).

12. **Sporormia Americana** sp. nov.

Perithecia scattered, sunken, with short black shining papilliform beak projecting onto the surface of the substratum, 175 μ–225 μ in diameter, globular to ovate, thin membranaceous to coriaceous, black and shining when removed from the substratum to which it is firmly attached.

Asci 8-spored, cylindrical-clavate, broadly rounded above and contracted below into a short stipitate base, 27–32 μ × 160–210 μ:

paraphyses abundant, filiform, slightly wider below than above, guttulate, septate, slightly longer than the asci and mixed with them.

Spores in 2 or 3 series, slightly fusiform and widest above the middle, 7-celled with the third from the upper end larger than the others, the five middle cells broader than long, the end cells slightly ovate and longer than broad, 10–13 μ × 54–62 μ, gelatinous envelope prominent. (*Pl. 17. f. 11–13.*)

Distinctive characters: The 7-celled spores.

Cultivated specimen: On rabbit dung, Gunnison, Colo., Aug. 1899 (Bartholomew).

The species appears to be intermediate between *S. vexans* and *S. heptamera* of the European botanists. The spores in the former are about 40 μ and in the latter 75 μ long. This difference is not confined to the spores but there is a constant difference in size throughout which appears to be intermediate between the two species. It appears to me, therefore, better to give this American form a new name, inasmuch as its measurements appear very constant and it cannot very well be included in either of the others.

13. SPORORMIA CORYNESPORA Niessl, Oest. bot. Zeitschrift, 167. 1878; Hedwigia, **17**: 148. 1878; Berlese Icones Fung. **1**: *pl. 31. f. 3.* 1894; Cohn's Krypt.-Flora Schlesien, **3**^{2}: 292. 1894; Rabenhorst, Krypt.-Flora, **1**^{2}: 186. 1887; Saccardo, Syll. Fung. **2**: 131. 1883.

Perithecia sunken and scattered or aggregated in small loose groups and erumpent, becoming free with age, 190–275 μ in diameter, subglobose to ovate with a short blunt black and shining papilliform beak, thin, coriaceous, black and opaque.

Asci 8-spored, clavate, broadly rounded above and contracted below into a short rather narrow stipe, quite persistent, 18–24 μ × 160–175 μ: paraphyses filiform, septate, a little larger below, slightly longer than the asci and mixed with them.

Spores in two or three series, 8-celled, slightly clavate with the third cell from the top abruptly larger than the others, end cells conical and broadly or acutely rounded, the remainder subglobose, 9–10.5 μ × 50–56 μ, covered with a narrow hyaline gelatinous envelope. (*Pl. 17. f. 8–10.*)

Distinctive characters: Spores with 8 cells with the third from the upper end larger than the others.

Dry specimen: On rabbit dung, Rooks Co., Kan., 1895 (Bartholomew no. 1929.)

Cultivated specimens: On rabbit dung, Gunnison, Col., Aug. 1899 (Bartholomew); rabbit dung, Decorah, Ia., July 1899 (Holway).

The Iowa specimen has spores a little smaller than others, often as low as 8 × 45 μ. In all other respects it is identical with the Kansas and Colorado specimens.

The American forms are identical in all respects with those of Europe; although the German descriptions vary greatly from mine. It is rather peculiar that so many observers should not have detected the real nature of the ascus. The ascus was originally described, and this error has been copied by others in later years, as having a long pedicel approaching in length the spore-bearing portion of the ascus. Even Berlese in his Icones as late as 1894 has figured the ascus in this condition. But Rehm's* specimens which were contributed and named by Niessl himself, show no such condition. On the contrary the asci when in a normal condition are very short-stipitate. The long stipe figured by Berlese and described by others is simply the old external membrane with the base of the expanded internal membrane. This rupture and stretching occurs very readily in dry specimens in this species as in many others. By allowing the perithecia to remain in iodized potassium iodide for a few minutes before rupturing, the asci may be studied in their natural condition. That Berlese had another plant cannot be maintained because he cites this same specimen as the one from which his figures were made.

14. SPORORMIA FIMETARIA DeNot. Memorie della R. Accad. delle Sci. de Torino, II. **10**: 10. 1849; Nuovo Gior. Bot. Ital. **10**: 160. 1878; N. Am. Pyren. 135. 1892; Rabenhorst, Krypt.-Flora, **1**^{2}: 187. 1887; Berlese, Icones Fungorum, **1**: *pl. 37. f. 4.* 1894; Saccardo, Syll. Fung. **2**: 132. 1883; Cohn's Krypt.-Flora, **3**^{2}: 393. 1894.

Sphaeria fimetaria Rabenh. Herb. Mycol. (Ed. I.) no. 1733 prop.†

Perithecia scattered, sunken beneath the thin upper crust of the substratum through which the upper wall of the perithecium

* Rehm's Ascomyceten, no. 748.

† Not seen.

opens onto the surface, 90–120 μ in diameter, thin membranaceous, brown, without any visible beak, the ostiolum being simply an opening in the wall of the perithecium.

Asci 8-spored, cylindrical, broadly rounded above and contracted below into a rather broad stout stipitate base, rather persistent, 12–16 $\mu \times$ 70–80 μ: paraphyses filiform, septate, sparingly branched, longer than the asci and mixed with them.

Spores parallel, firmly united into a cylindrical truncate mass in the center of the ascus, 3.5–4 $\mu \times$ 50–54 μ, 16-celled with the end cells nearly twice the length of the others, the whole mass of spores surrounded by a very narrow hyaline gelatinous covering which does not adhere to the individual spores when isolated. (*Pl. 17. f. 4–6.*)

Distinctive character: Fasciculated spores.

Cultivated specimens: On cow dung, Proctor, Vt., Aug. 1899 (Banker); cow dung, Rooks Co., Kan., July 1899 (Bartholomew); cow dung, Austin, Texas, Jan. 1900 (Long); sheep dung, Biloxi, Miss., Sept. 1899 (Tracy); sheep dung, Brookings, S. D., Nov. 1899 (Carter).

15. SPORORMIA HERCULEA E. & E., N. Am. Pyren. 135. 1892; Saccardo, Syll. Fung. **11**: 329. 1895

Perithecia sunken, scattered, with a projecting black cylindrical beak which terminates in an enlarged black warty irregularly expanded or even forked extremity, about 440–550 μ in diameter, globular, membranaceous to coriaceous, sometimes inclined to be brittle, black, and opaque.

Asci 8-spored, clavate or slightly fusiform, broadly rounded above and contracted below into a short blunt stipe, quite persistent, 45–60 $\mu \times$ 225–300 μ: paraphyses filiform, abundant, septate, slightly constricted below, longer than the asci and mixed with them.

Spores obliquely two- or three-seriate, 11–16-celled, cylindrical to very slightly fusiform, rounded or subacute at the ends, deeply constricted and easily separable into individual cells, 18–21 $\mu \times$ 135–150 μ; the second to the fifth cell from above in the upper spore of ascus being much larger than any of the others; ordinary cells 13–16 $\mu \times$ 16–21 μ; large cell about 18 $\mu \times$ 24 μ, ranging from hyaline and decidedly fusiform when young through yellow to dark brown opaque and cylindrical. (*Pl. 17. f. 1–3.*)

Distinctive characters: The peculiar beak of the perithecium and the peculiar upper spore of the ascus.

Dry specimens: On cow dung, Newfield, N. J., March and Apr. 1891 (Ellis).

Cultivated specimens: On cow dung, New York City and Ft. Lee, N. J., summer and autumn 1899; cow dung, Kingston, R. I., Dec. 1899 (Underwood); cow and horse dung, Austin, Texas, Jan. 1900 (Long).

There is, in some respects, quite a difference between the northern and southern specimens of this plant, but it appears to be a difference produced by variation rather than a distinct character. Some of the Texas material had spores as low as 110 μ long, the perithecia were often very small, and contained but a half dozen asci, while the large cell was usually found nearer the upper end of the spore. In the northern specimens the position of the large cell lies somewhere between the third and the fifth, but in the Texas material it is usually found from the second to the third cell from the top of the upper spore.

VI. SPORORMIELLA E. & E., N. Am. Pyren. 136. 1892

Perithecia imbedded in a stroma. Asci with a functional internal membrane which stretches at maturity. Spores 4-celled and surrounded by a hyaline gelatinous envelope. Indistinguishable from *Sporormia* except for the presence of a stroma. A single species.

1. SPORORMIELLA NIGROPURPUREA E. & E., N. Am. Pyren. 136. 1892; Saccardo, Syll. Fung. **11**: 330. 1895; Lindau, Die natürlichen Pflanzenfamilien, **1**^{1}: 393. 1897.

Perithecia scattered or aggregated in large clusters and imbedded in a dark gray stroma which is purplish within, sunken or slightly elevated when confluent, subglobose or ovate, thick-walled with papilliform black shining and perforate beak about .35 mm. in diameter.

Asci 8-spored, cylindrical-clavate, broadly rounded above and gradually contracted below into a short crooked stipe, 10–12 $\mu \times$ 90–125 μ: paraphyses filiform, abundant, faintly guttulate, faintly septate, much longer than the asci and mixed with them.

Spores 4-celled, cylindrical, deeply constricted, rounded at the ends, 20–26 $\mu \times$ 4–6 μ, terminal cells subovate, middle ones subglobose; hyaline envelop narrow and indistinct. (*Pl. 15. f. 1–3.*)

Dry specimens: On cow dung, Newfield, N. J., March 1891 (Ellis).

SUMMARY

I. Seventy-eight species are recognized for the region indicated in the title of this article. Thirty-two of these are new to

science, and twenty others are recorded for North America for the first time.

II. Our knowledge of the distribution of species, especially within the United States, has been greatly extended—material from over twenty states having been studied during the progress of the investigation.

III. The period of development of many of the species has been determined—sixty four of the seventy eight species having been cultivated and studied in the living condition.

IV. The function of spore dissemination has been critically studied.

V. A better knowledge of the mechanism of spore ejection has established a firmer and more definite foundation for the genera.

VI. Methods have been evolved for securing pure cultures of a large number of the species.

VII. Facts have been added to our knowledge of the relationship of the genus *Hypocopra* to the Xylariaceae.

BIBLIOGRAPHY

de Albertini, J. B., & de Schweinitz, L. D. Conspectus Fungorum in Lusatiae superioris agro Niskiensi crescentium 33. 1805.

Auerswald, B. Delitschia Awd. nov. gen. e grege sphaeriacearum simplicium et affinitate Sordariarum et Amphisphaeriarum. Hedwigia, **5**: 49, 50. 1866.

——— Die Sporormia Arten. Hedwigia, **7**: 65. *pl. 1.* 1868.

——— Hormospora oder Sporormia? Hedwigia, **7**: 137. 1868.

DeBary, Anton. Comparative Morphology and Biology of the Fungi, Mycetozoa and Bacteria. 78, 79, 85–88, 91, 92, 101–104, 191, 192, 198, 199, 210, 224, 235, 243, 260, 261, 343, 344, 350, 357. *f. 44, 52.* 1887.

Banke, Hermann. Zur Entwicklungsgeschichte der Ascomyceten. Bot. Zeitung, **35**: 313-326. 1877.

Berkeley, M. J. Notices of North American Fungi. Grevillea, **4**: 93, 143. 1876.

Berlese, A. N. Icones Fungorum, **1**: VIII, 41–44. *pl. 11; pl. 12. f. 1.* (*Genera*); *pl. 28. f. 2–7; pl. 29–32; pl. 37. f. 4.* 1894. **2**: 68. *pl. 98. f. 1.* 1896.

Bommer, E., & Rousseau, M. Contributions a la flore mycologique de Belgique, I. Bull. Soc. Royale Bot. Belg. **25**: 170, 171. 1886.

——— Contributions a la flore mycologique de Belgique, II. Bull. Soc. Royale Bot. Belg. **26**: 200. 1887.

——— Contributions a la flore mycologique de Belgique. Bull. Soc. Royale Bot. Belg. **29**: 256, 257. 1890.

——— Florule mycologique des environs de Bruxelles. Bull. Soc. Royale Bot. Belgique, **23**: 196–200. 1884.

Borzi, A. Studii sulla sessualita degli Ascomiceti. Nuovo Giornale Botanico Itãliano, **10**: 43–78. 1878.

Brefeld, Oscar. Untersuchungen aus dem Gesammtgebiete der Mykologie, **10**: 195–198. *pl. 6.* 1891.

Bresadola, G., & Saccardo, P. A. Enumerazione dei funghi della Valsesia. Malpighi, **11**: 285–290. 1897.

Cavara, Fridianor. Fungi Longobardiae exsiccati, nos. 36, 83, 121, 226. 1892–1894.

Cesati, V. Hedwigia, **1**: 103. *pl. 14. f. A and B.* 1852.

Cesati, V., & DeNotaris, G. Schema di classificazione degli Sfereace Italici. Comment. Soc. Crit. Italiana, **1**: 225–227. 1863.

Cooke, M. C. Hand-book of British Fungi, 847, 866–874. 1871.

——— Synopsis Pyrenomycetum. Grevillea, **16**: 154–156. 1887.

——— The Fungi of Texas. Annals N. Y. Acad. Sci. **1**: 186. 1878.

——— Fungi Britannici exsiccati, no. 587.

Cooke, M. C., & Plowright, C. B. British Sphaeriacei. Grevillea, **7**: 85, 86. 1879.

Corda, A. C. I. Icones Fungorum, **2**: 29. *pl. 13. f. 105.* 1835.

Currey, Frederick. Synopsis of the Fructification of the Simple Sphaeriae of the Hookerian Herbarium. Trans. Linn. Soc. **22**: 320, 321. *pl. 57. f. 39, 40, 50; pl. 58. f. 56.* 1859.

——— Synopsis of the Fructification of the Compound Sphaeriae of the Hookerian Herbarium. Trans. Linn. Soc. **22**: 273. *pl. 57. f. 102.* 1858.

——— Supplementary observations on the Sphaeriae of the Hookerian Herbarium. Trans. Linn. Soc. **25**: 253, 254, 255, 257. 1865.

Desmazieres, J. B. H. J. Plantes Cryptogames. Ann. Sci. Nat. III. **11**: 353. 1849.

——— Plantes Cryptogamiques de France, no. 709. 1849.

Ellis, J. B. Bull. Torr. Club, **6**: 109. 1876.

Ellis, J. B., & Everhart, B. M. North American Pyrenomycetes, 126–136. 1892.

——— New Species of Fungi from various Localities. Jour. Mycol. **4**: 66, 67. 1888.

——— New Species of Fungi from various Localities. Bull. Torr. Club, **25**: 501. 1898.

——— New Species of Fungi from various Localities. Bull. Torr. Club, **24**: 458. 1897.

——— New Species of Fungi from various Localities. Am. Nat. **31**: 340, 341. 1897.

——— New Species of Fungi from various Localities. Jour. Mycol. **3**: 118. 1887.

Eidam, Eduard. Kenntniss der Entwicklung bei den Ascomyceten. Cohn's Beitrage zur Biologie der Pflanzen, **3**: 377–425. 1883.

Fabre, J. H. Assai sur les Sphéreacées du Départment de Vaucluse. Ann. Sci. Nat. VI. **9**: 76–81. 1878.

Fries, Elias. Summa Vegetab. Scand. 384, 397. 1849. Elenchus Fungorum, **2**: 100. 1830.

Fuckel, L. Symbolae Mycologicae, 239–246. 1869.

——— Symbolae Mycologicae, Nachtrag **1**: 37, 38. 1871; **2**: 43–45. 1873; **3**: 26. 1875.

Griffiths, David. Contribution to a better Knowledge of the Pyreno mycetes, I. Bull. Torr. Club, **26**: 432–444. *pl. 365. f. 1–18.* 1899.

——— A Study in Spore Dissemination. Asa Gray Bull. **8**: 27–32. *pl. 2.* 1900.

Grove, W. B. New and noteworthy Fungi (Part III). Jour. Bot. **24**: 132. *pl. 266. f. 1.* 1886.

Hansen, Emil Christian. Fungi fimicoli Danici. Naturhist Forening i Kjobenhavn Videnskabelige Middelelser for Aarene, 207–354. *pl. 6–9.* 1876.

Hennings, P. Fungi Camerunensis, I. Engler's Bot. Jahrb. **22**: 77. 1897.

Harkness, H. W., & Moore, J. P. Catalogue of Pacific Coast Fungi.

——— Fungi of California and the Sierra Nevada Mountains. Grevillea, **5**: 118. 1876.

Hooker, W. J. Fungi. Smith's English Flora, **5**^{2}: 246, 261, 264. 1836.

de Jaczewski, A. Essai de classification naturelle des Pyrénomycètes. Bull. Soc. Mycol. France, **10**: 13–48. 1894.

——— Catalogue des Champignons recueillis en Russie en 1892 à Rylkowo, gouvernment de Smoleusk. Bull. Soc. Mycol. de France, **9**: 216. 1893.

Karsten, P. A. Revisio Monographica atque Synopsis Ascomycetum in Fennica. Acta Soc. pro Fauna et Flora Fenn. (Helsingfors) **2**: 20–24, 46, 70, 77–79. 1881–1885.

——— Fragmenta Mycologica 28. Hedwigia, **28**: 366, 367. 1889.
——— Fungi in insulis Spetzbergen et Beeren Eiland collecti. Öfersigt af kongliga Vet. Akad. Forhandl. 91. 1872.
——— Mycologia Fennica, **2**: 4–6, 8, 60. 1873.
Krieger, W. Fungi Saxonici exsiccati. Hedwigia, **35**: (143), (144). 1896.
——— Fungi Saxonici exsiccati. Nos. 32, 33, 74, 166, 167, 274–276, 371.
Kuntze, Otto. Revisio Genarum Plantarum, 3^1: 486, 504, 505. 1898.
Kunze, Jos. Fungi Selecti Exsiccati. Nos. 100–102.
Kunze, Gustav. Mykologische Hefte **2**: 38. 1823.
Lamarck, J. B. P. A. & De Candolle, A. P. Flore Française (Edit. 3), **2**: 294. 1815.
Lambotte, E. Flore mycologique Belgique. **2**: 431–436. 1880.
Lindau, Gustav. Pyrenomycetineae. Die natürliche Pflanzenfamilien $\mathbf{1}^1$: 390–393. *f. 253, 254.* 1897.
Leunis, Johannes, & Frank, A. B. Synopsis der Pflanzenkunde, **3**: 345–346. 1886.
Ludwig, Friedrich. Lehrbuch der niederen Kryptogamen, 298–300. 1892.
Maistriau, C., & Ronflette, C. Quelques plantes plus on moins rares observées à Beloeil et dans les environs pendant l'année 1884. Bull. Soc. Royale Bot. Belgique, $\mathbf{23}^2$: 163, 164. 1884.
Marchal, Élie. Champignons coprophiles de la Belgique, I. Bull. Soc. Royale Bot. Belgique, $\mathbf{23}^2$: 9–17. 1884.
——— Champignons coprophiles de la Belgique, II. Bull. Soc. Royale Bot. Belgique, **23**: 196–200. 1884.
——— Champignons coprophiles de la Belgique, III. Bull. Soc. Royale Bot. Belgique, **23**: 90–92. 1884.
——— Champignons coprophiles de la Belgique, IV. Bull. Soc. Royale Bot. Belgique, **24**: 57–59. *pl. 3. f. 7–9.* 1885.
——— Champignons coprophiles de la Belgique, VII. Bull. Soc. Royale Bot. Belgique, **34**: 129. 1895.
Martins, F. P. Flora crypt. Erlangensis, p. 494. 1817.
Montagne, J. F. C. Sylloge Cryptogamarum, 227. 1856.
Mouton, V. Ascomycètes observés aux environs de Liége, I. Bull. Soc. Royale Bot. Belg. **25**: 144, 145, 151, 152, 155, 156. *pl. 4.* 1886.
——— Ascomycètes observés aux environs de Liége, II. Bull. Soc. Royale Bot. Belg. **26**: 175, 176. *pl. 1. f. 4–8.* 1887.
——— Troisième notice sur des ascomycétes. Bull. Soc. Royale Bot. Belg. **36**: 11–14. *pl. A. f. 2, 3, 8.* 1897.

Niessl, G. von. Über die Theilung der Gattung Sordaria. Hedwigia, **22**: 153–156. 1883.

——— Über Sordaria appendiculata Awd. und S. curvula DeBary. Hedwigia, **12**: 161–165. 1873.

——— Beiträge zur Kenntniss der Pilze (Review). Hedwigia, **12**: 130, 131. 1873.

——— Notizen über neue und kritische Pyrenomyceten. Verhand. naturforsch. Vereines (Brünn), **14**: 207, 208. *pl. 4. f. 22, 23.* 1876.

——— Die Arten der Pyrenomyceten-Gattung Sporormia de Not. Oest. Bot. Zeitschrift, 41–45, 95–98, 121–127, 163–168. 1878. (This paper has not been seen.) See also under Winter.

Nichols, Mary A. The Morphology and Development of certain pyrenomycetous Fungi. Bot. Gaz. **22**: 301–328. *pl. 14–16.* 1896.

de Notaris, G. Sferiacei Italici. Mem. R. Accad. Sci. di Torino, **1**^{1}: 21–24. *f. 18–21.* 1863.

——— Nuove reclute per la Pirenomicetologia Italica. Comm. Soc. Critt. Italiana, **2**: 479–481. 1864.

Oudemans, C. A. J. A. Notiz über einige neue Fungi Coprophili. Hedwigia, **21**: 161–166. 1882.

——— Sordariae novae. Hedwigia, **21**: 123, 124. 1882.

Passerini, G. Fungi raccolti in Abissinia dal Signor O. Beccari. Nuovo Gior. Bot. Ital. **7**: 190. *pl. 5. f. 14.* 1875.

Patouillard, N., & Lagerheim, G. Champignons l'Équateur. Bull. Soc. Mycol. France, **11**: 226. 1895.

Peck, C. H. Report of the Botanist. Reg. Rep. **28**: 78, 79. *pl. 2. f. 14–17.* 1875.

Penzig, O., & Saccardo, P. A. Diagnosis fungorum novorum in insula Java collectorum. Malpighia, **11**: 395. 1897.

Persoon, C. H. Synopsis Methodica Fungorum 64. 1801.

Phillips, W., & Plowright, C. B. New and rare British Fungi. Grevillea, **2**: 187–189. *pl. 25.* 1874. **6**: 28, 29. *pl. 94.* 1877; **9**: 72, 73. *pl. 158. f. 1.* 1881; **13**: 76. 1885.

Pirotta, R. Saggro d'una Monografia del Genere Sporormia. Nuova Gior. Bot. Ital. **10**: 127–163. *pl. 6. f. 1–23.* 1878.

Plowright, Charles B. Fungi of Norfolk. Mason's History of Norfolk (reprint p. 16). 1884.

——— Californian Sphaeriae. Grevillea, **7**: 71, 72. 1878.

——— Sphaeriacei Britannici, Cent. 1, nos. 64–74. 1873; Cent. 3, nos. 43–46. 1878.

Preuss, G. T. Übersicht untersuchter Pilze, besonders aus der Umgegend von Hoyerswerda. Linnaea, **26**: 714. 1853.

Rabenhorst, L. *Malinvernia* nov. gen. Hedwigia, **1**: 116. *pl. 15. f. 4.* 1857.

——— Sferiacei Italici (review). Hedwigia, **2**: 173, 174. 1863.

——— Fungi Europaei exsiccati (Cent. XIV.). Hedwigia, **9**: 137. 1870.

——— Die deutschen Sordarien (review). Hedwigia, **12**: 163. 1873.

——— Notizen über neue und kritische Pyrenomyceten (Reprint of description). Hedwigia, **16**: 12, 13. 1877.

——— Fungi Europaei, nos. 954, 1140, 1339, 1528, 2226 a and b, 2432, 3254. All numbers quoted issued between 1865 and 1885.

Ravenel, H. W. Fungi Caroliniani exsiccati, No. 61. 1852–1860.

Rehm, H. Ascomycetes (fasc. XV.). Hedwigia **23**: 74–76. 1884.

——— Ascomycetes (fasc. XIX.). Hedwigia, **27**: 174. 1888.

——— Ascomycetes (fasc. XX.). Hedwigia, **28**: 355. 1889.

——— Ascomycetes (fasc. XXI.). Hedwigia, **30**: 160. 1891.

——— Ascomyceten (Exsiccati) Nos. 34, 134, 136–138, 198–200, 233–235, 300, 748, 988. 1872—current.

Roumeguère, C. Fungi selecti exsiccati, Nos. 587, 1192, 2193, 2764, 3041, 3042, 3049, 3539, 3948, 3950, 5041, 5640, 6489, 6490, 6491, 6637, 6690, 6892. 1879—current.

Saccardo, P. A. Sylloge Fungorum, **1**: 23–252; **2**: 123–132; **9**: 487–495, 816–820; **11**: 329–330; **14**: 492–494, 558, 577. 1882–1899.

——— Genera Pyrenomycetum, *pl. 3. f. 17–20; pl. 6. f. 17; pl. 7. f. 13; pl. 9. f. 8.*

——— Fungi Veneti, VI., Michelia, **1**: 26, 27. 1877.

——— Fungi Veneti, IX., Michelia, **1**: 363–374. 1877.

——— Mycotheca Veneta, Nos. 1177–1184, 1492. 1874–1880.

——— Fungi Veneti novi vel critici. Nuovo Gior. Bot. Ital. **8**: 178. 1876.

Saccardo, P. A., & Berlese, A. N. Catalogo del Fungi Italiani, 46, 47, 57.

Schroeter, J. Pyrenomycetineae. Cohn's Kryptogamen-Flora von Schlesien, 3^2: 284–293. 1894.

Sowerby, James. English Fungi, *pl. 357.* 1803.

Spegazzini, Carolo. Fungi Argentini. Pugilli I–IV. Annal. Soc. Cient. Argent. 181–183; 19–25; 15–17; 48. 1880–1882.

——— Fungi Fuegiana, 57–60, 83, 90–92. Boletin de la Acad. Nacional de Ciencas de Córdoba, **11**: 135. 1887.

——— Fungi Patagonici, 36–38, 42–49. Boletin de la Acad. Nacional de Ciencas de Córdoba, **11**: 5. 1887.

——— Fungi Coprophili Veneti. I. Michelia, **1**: 223–231. 1871.

Sydow, Paul. Mycotheca Marchica. Nos. 42, 668, 864, 2338, 2339, 2555, 4648, 4649.

Von Tavel, F. Vergleichende Morphologie der Pilze, 78, 85. *f. 39.* 1892.

Van Tieghem, Ph. Neue Beobachtungen über die Fruchtentwickelung und die vermeintliche Sexualität der Basidiomyceten und Ascomyceten. Bot. Zeitung, **34**: 165, 166. 1876.

——— Sur le développement du fruit des Chaetomium et la prétendue sexualité des Ascomycètes. Ann. Sci. Nat. VI. **2**: 364. 1875.

de Thümen, F. Fungi Austriaci. No. 1152.

——— Mycotheca Universalis. Nos. 655 & 2168.

Underwood, L. M. Moulds, Mildews and Mushrooms, 47, 48. 1899.

Vize, J. E. Micro-Fungi Britannici. Nos. 288–290. 1878—.

Wagner, Harold. The Sexuality of the Fungi. Ann. Bot. **13**: 575–597. 1899.

Ward, H. Marshall. On the Sexuality of the Fungi. Quart. Jour. Micros. Sci. **24**: 262–293. 1884.

Winter, George. Die deutschen Sordarien. Abhand. der naturforsch. Gesell. zu Halle, **13**^{1}: 67–107. *pl. 7–11.* 1877.

——— Diagnosen neuer Pilze. Hedwigia, **10**: 161, 162. 1871.

——— Mikologische Notizen. Hedwigia, **13**: 50–57. *pl. 1.* 1874.

——— Fungi fimicoli Danici (review). Hedwigia, **17**: 92–95. 1878.

——— Die arten der Pyrenomyceten-Gattung Sporormia (review). Hedwigia, **17**: 145–149.

——— Rabenhorst's Fungi Europaei. Hedwigia, **21**: 10. 1882.

——— Nachträge und Berichtigungen zu Saccardo's Sylloge Fungorum, 1 and 2. Hedwigia, **24**: 98. 1885.

——— Rabenhorst Kryptogamenflora, **1**^{2}: 162–187, *figured.* 1887.

Woronin, M. Sphaeria Lemneae, Sordaria fimiseda, Sordaria coprophila und Arthrobotrys oligospora. Abhand. du Senkenb. naturforch. Gesell. (Frankfurt), **7**: 325–360. *pl. 1–6.* 1869–1870.

Zimmerman, O. E. R. Revue Mycologique, **1**: 58. 1879.

Zopf, Willhelm. Zur Kenntniss der anatomischen Anpassung der Pilzfrüchte an die Funktion der Sporenentleerung. Zeitschrift für die gesammt Naturwissenschaften, **56**: 539–574. *pl. 6–8.* 1883.

——— Der Pilze. Schenk's Handbuch der Botanik, **4**: 316, 337–340, 358–370, 476, 497, 725. *f. 58, 60.* 1890.

Zukal, Hugo. Entwicklungsgeschichtliche Untersuchungen aus dem Gebiete der Ascomyceten. Sitzungsb. der Kais. Akad. Wissensch. (Wien), **98**[1] : 518–603. *pl. 1, 2.* 1889.

——— Mykologische Mittheilungen. Oest. Bot. Zeitschrift, 1893. pp. 168, *figured* (Review in Hedw. **32** : 411. 1893).

——— Ueber einige neue Pilze, Myxomyceten und Bakterien. Verhand. K. K. zool.-bot. Gesellschaft, **35** : 338. *pl. 15. f. 1.* 1885.

Explanation of Plates

NOTE: Where no magnifications are given an enlargement of 35 diameters for perithecia, 230 for asci and 310 for spores is to be understood. The illustrations were drawn from a magnification double that here given and reduced one half in the process of reproduction.

PLATE 1

1. Ascus of *Delitschia Winteri* which was ruptured near the base by rough treatment, × 230.
2. Ascus of *Delitschia furfuracea* ruptured under the cover-glass, × 230.
3. Expanding ascus of *Pleurage zygospora*, × 230.
4. Expanding ascus of *Pleurage vestita.*
5. Outline of the apex of the expanding ascus of *Pleurage Kansensis.*
6. Perithecium of *Pleurage curvicolla* grown in a shaded place and its position changed several times causing the heliotropic curvatures and elongation of the beak. Only the three asci having dark spores are shown. One is seen a little in advance of the others and they are all twice as long as the younger hyaline-spored asci which are not represented and could not be seen, × 35.
7. Perithecium of *Pleurage minuta*, showing expanding asci, × 50.
8. Apex of perithecium of *Pleurage adelura*, showing a protruding ascus, × 230.
9. Perithecium of *Pleurage curvicola*, showing outline of expanding asci. There are here 4 asci with dark colored spores, × 50.

PLATE 2

1. Apex of perithecium of *Sporormia Dakotensis* in the act of discharging spores, × 230. The drawing was made with a camera lucida while the perithecium was mounted in water. The position of each ascus was marked and one drawn with the camera; the others were then traced in the proper positions. The loose spores were traced in as nearly as possible similar positions to those assumed by ejected spores. The relative distance was obtained by measurement.
2. Ascus of *Sporormia intermedia* in process of eruption.
3. Ascus of *Sporormia Americana* in process of eruption.
4. Apex of perithecium of *Sporormia intermedia* in process of eruption.
5. Ascus of *Sporormia corynespora* in process of eruption.
6. An ascus of *Sporormia megalospora* ruptured at the base by rough treatment.
7. Ascus of *Sporormia leporina* in process of eruption.
8. Ascus of *Sporormia minima* is process of eruption.
9. Ascus of *Sporormia herculea* in process of eruption.

PLATE 3

1–3. *Sordaria Montanensis.* 1. Perithecium. 2. Ascus. 3. Spore.

4–8. *Sordaria discospora.* 4. Perithecium. 5. Ascus with uniseriate spores. 6 Ascus with biseriate spores; 5 and 6 are from the same perithecium. 7–8. Different views of spores.

9–15. *Sordaria leucoplaca.* 9. Perithecium on cow dung from Highmore, S. D. 10–12. Perithecia on horse dung from New York City. 13. Asci, one of which shows the aborting spores. 14. Ascus with slightly larger spores from New York City. 15. Three spores.

16–18. *Sordaria humana* on dog dung, New York City. 16. Perithecium. 17. Ascus. 18. Spore.

19–21. *Sordaria fimicola* on dead culms of *Eleocharis* from Aberdeen, S. D. 19. Perithecium. 20. Ascus. 21. Spore.

22–24. *Sordaria humana* on goat dung from New York City. 22. Perithecium. 23. Ascus slightly stretched. 24. Spores.

25–27. *Sordaria minima.* 25. Two perithecia. 26. Ascus. 27. Spore. Ascus and spore not fully mature.

28–30. *Sordaria hyalina* 28. Perithecium. 29. Ascus. 30. Spores.

PLATE 4

1–3. *Pleurage tetraspora.* 1. Perithecium. 2. Ascus. 3. Spore.

4–7. *Sordaria bombardioides.* 4. Perithecium with perfectly diagrammatic substratum to show extent to which it is sunken. 5. Outline of perithecium after removal of outer layer. 6. Ascus. 7. Spore.

8–10. *Sordaria fimicola* drawn from specimens on cow dung in Columbia greenhouse. 8. Perithecium. 9. Ascus. 10. Spore.

11–13. *Pleurage erostrata.* 11. Perithecium. 12. Ascus. 13. Spore.

14–16. *Sordaria humana* on human ordure, Newfield, N. J. (Ellis). 14. Perithecium. 15. Ascus. 16. Spore.

17–19. *Sordaria philocoproides.* 17. Perithecium. 18. Ascus. 19. Spore.

20–21. Germinating spores of *Pleurage curvula.*

PLATE 5

1–3. *Pleurage Ellisiana.* 1. Perithecium. 2. Ascus. 3. Spore.

4–6. *Pleurage anserina.* 4. Perithecium. 5. Ascus. 6. Spore. The gelatinous appendages at base of spore are not often present.

7–9. *Pleurage anomala.* 7. Perithecium. 8. Ascus. 9. Spore.

10–13. *Pleurage albicans.* 10. Perithecium. 11. Ascus. 12. Mature spore. 13. Young spore.

14–20. *Pleurage arachnoidea.* 14. Perithecium. 15. Mature ascus. 16. Young ascus. 17. Spore. 18. Young spore. 19. Spore showing removal of septum downward. 20. Spore showing a septum in the primary appendage.

PLATE 6

1–3. *Pleurage taenioides.* 1. Perithecium. 2. Ascus. 3. Spore.

4–6. *Pleurage Arizonensis.* 4. Perithecium. 5. Ascus. 6. Spore.

7–9. *Pleurage multicaudata.* 7. Perithecium. 8. Ascus. 9. Spore.

PLATE 7

1–6. *Pleurage curvula.* 1. Perithecium cultivated on dead stems of *Salsola Kali Tragus* from Aberdeen, S. D. 2. Perithecium cultivated on cow dung from New York City. 3. Apex of no. 2, × 230. 4. Hairs of no. 3, × 315. 5. Ascus. 6. Apical and lateral views of spores. The gelatinous appendage attached to the side of the primary one is seldom seen.

7–10. *Pleurage minuta.* 7. Perithecium. 8. Ascus. 9. Apical view of a spore. 10. Side view of a spore. The gelatinous appendages attached near the base of the spore are seldom seen.

11–13. *Pleurage amphicornis.* 11. Perithecium. 12. Ascus. 13. Spore.

14–16. *Pleurage minor.* 14. Perithecium. 15. Ascus. 16. Spore.

17–19. *Pleurage Dakotensis.* 17. Perithecium. 18. Ascus. 19. Spore.

PLATE 8

1–5. *Pleurage fimiseda.* 1. Perithecium. 2. Ascus. 3. Apex of ascus showing position of the gelatinous appendage. 4. Spore. 5. A hair from the perithecium, × 315.

6–8. *Pleurage Kansensis.* 6. Perithecium. 7. Ascus. 8. Spore.

9–11. *Pleurage longicaudata.* 9. Perithecium. 10. Ascus. 11. Spore.

PLATE 9

1–4. *Pleurage zygospora.* 1. Perithecium. 2. Mature ascus. 3. Spore. 4. Young ascus.

5–8. *Pleurage vestita.* 5. Perithecium. 6. Ascus. 7. Apical view of a spore. 8. Spores as ordinarily seen without secondary appendages. 9. Mature spore.

10–13. *Pleurage decipiens.* 10. Perithecium. 11. Ascus. 12. Spore slightly under maturity. 13. Spore slightly beyond maturity.

PLATE 10

1–6. *Pleurage curvicolla.* 1. Perithecium. 2. Mature ascus. 3. Young ascus. 4. Spore. 5. Spore, apical view. 6. Spores in different stages of development.

7–10. *Pleurage pleiospora.* 7. Perithecium. 8. Ascus. 9. Mature spore. The gelatinous appendages at the base of the spore are often very difficult to distinguish. 10. Young spore.

11–13. *Pleurage adelura.* 11. Perithecium. 12. Ascus. 13. Two spores. The one with long appendages is rather under maturity. The cther is mature and the gelatinous appendages are shown as they appear in the stretching ascus. When the ascus has ruptured they usually entirely disappear.

14–18. *Pleurage collapsa.* 14. Perithecium. 15. Ascus. 16. Spore with the apical gelatinous filament long drawn out. (See description.) 17. Spore showing appendages normal as they appear in the expanding ascus. 18. Young spore.

PLATE 11

1–4. *Hypocopra equorum* * from Colorado. 1. Perithecium showing form of individual stroma. 2. Ascus. 3. Spore. 4. Apex of ascus showing the apical body which colors blue with iodine, × 315.

5–7. *Hypocopra amphisphaeroides.* 5. Perithecium showing stromatic layer in section. 6. Ascus. 7. Spore.

8–11. *Hypocopra equorum* * from Aberdeen, S. D. 8. Perithecia showing the thin flat crust-like stroma through which the beaks of the perithecia project. 9. Ascus. 10–11. Spores with and without hyaline covering, 11 showing the lateral germ slit.

12–15. *Hypocopra gigaspora.* 12. Perithecium with stroma in section through which the beak appears erumpent. 13. Ascus. 14. Spore. 15. Ascus apex, × 315.

PLATE 12

1–5. *Hypocopra violacea.* 1. Perithecium shown to be completely imbedded in a more or less perfect stroma. In all other species the mycelium is not condensed except at the surface where it forms a thin stromatic crust. 2. Diagram traced from hand section showing the boundary of the stroma. 3. Ascus. 4. Apex of ascus, × 315. 5. Spore.

6–8. *Hypocopra Dakotensis.* 6. Perithecium drawn when the edge of the stromatic shield was composed of colorless radiating hyphae which had not become differentiated into a stroma. The boundary line represents the edge of this mycelium. 7. Asci. 8. Different views of three spores.

9–14. *Hypocopra merdaria.* 9. Perithecium showing a rather small individual stromatic shield. 10 Ascus. 11. Ascus of one of Plowright's specimens named by Winter. More details are omitted in this than the other. 12. Apex of mature ascus, × 315. 13. Apex of young ascus, × 315. 14. Mature spore.

15–18. *Hypocopra rostrata.* 15. Perithecium showing the pseudo-stroma in section. 16. Asci, one showing the arrangement assumed by the spores when mounted in water. 17. Ascus apex, × 315. 18. Two spores.

PLATE 13

1–3. *Delitschia Marchalii.* 1. Perithecium. 2. Ascus. 3. Spores.

4–6. *Delitschia didyma.* 4. Perithecium. 5. Ascus. 6. Spore.

7–9. *Delitschia eccentrica.* 7. Perithecium. 8. Ascus. 9. Spore.

10–13. *Delitschia apiculata.* 10. Perithecium. 11. Ascus. 12. Spore. 13. Hair from beak of perithecium.

14–16. *Delitschia leporina.* 14. Perithecium. 15. Asci 16. Spores.

PLATE 14

1–3. *Delitschia polyspora.* 1. Perithecium. 2. Ascus. 3. Spore.

4–6. *Delitschia vulgaris.* 4. Perithecium. 5. Ascus. 6. Spore.

7–9 *Delitschia furfuracea.* 7. Perithecium. 8. Ascus. 9. Spore.

10–12. *Delits hia Winteri.* 10. Perithecium. 11. Ascus. 12. Spore.

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* These figures were made at a time when I thought that these two forms were distinct, but subsequent cultures, from Brookings, S. D., especially, showed every gradation of spore and stromatic characters between the two extremes figured here.

PLATE 15

1–3. *Sporormiella nigropurpurea.* 1. Perithecium. 2. Ascus. 3. Spore.
4–6. *Sporormia chrysospora.* 4. Perithecium. 5. Ascus. 6. Spore.
7–9. *Sporormia Dakotensis.* 7. Perithecium. 8. Ascus. 9. Spore.
10–12. *Sporormia pulchella.* 10. Perithecium. 11. Ascus. 12. Spore.
13–15. *Sporormia tuberculata.* 13. Perithecium. 14. Ascus. 15. Spore.
16–18. *Sporormia minima.* 16. Perithecium. 17. Ascus. 18. Spore.
19–21. *Sporormia intermedia.* 19. Perithecium. 20. Ascus. 21. Spore.
22–24. *Sporormia leporina.* 22. Perithecium. 23. Ascus. 24. Spore.

PLATE 16

1–3. *Sporormia megalospora.* 1. Perithecium. 2. Ascus. 3. Spore.
4–6. *Sporormia chaetomioides.* 4. Perithecium. 5. Ascus. 6. Spore.
7–9. *Sporormia Kansensis.* 7. Perithecium. 8. Ascus. 9. Spore.
10–12. *Sporormia lata.* 10. Perithecium. 11. Ascus. 12. Spore.

PLATE 17

1–3. *Sporormia herculea.* 1. Perithecia. 2. Ascus. 3. Spores.
4–7. *Sporormia fimetaria.* 4. Perithecium. 5. Asci, × 630. 6. Ascus, × 460. 7. Spore.
8–10. *Sporormia corynespora.* 8. Perithecium. 9. Ascus. 10. Spore.
11–13. *Sporormia Americana.* 11. Perithecium. 12. Ascus. 13. Spore.

PLATE 18

1. Abnormal perithecium of *Pleurage zygospora.* Two functional beaks are developed.

2. Abnormal perithecium of *Pleurage vestita* with two functional beaks.

3. Abnormal perithecium of *Pleurage decipiens* with forked beak.

4. Abnormal perithecium of *Sordaria fimicola* with two functional beaks.

5. Forked beak of *Pleurage vestita.*

6. Two abnormal asci of *Pleurage decipiens.* The ascus wall has in each case been transformed into a dark brown tissue like the spore wall. One of the asci has become biseptate.

7. Abnormal ascus of *Pleurage Kansensis* which has been transformed into a spore of the same shape as the ascus.

8. Abnormal one-spored ascus of *Pleurage taenioides.*

9–13. Abnormal spores of *Pleurage zygospora.* All sorts of abnormalities are found in the spores of this species.

14. Beak of perithecium of *Sordaria fimicola.* A column of spores of the same diameter as the ostiolum is being pushed out.

15–17. Showing the development of the ascus in *Pleurage zygospora.* In the last are shown young spores.

18. Young spore of *Pleurage zygospora.*

19–22. Outlines of successively older spores of *Pleurage zygospora.*

PLATE 19*

1–3. *Pleurage heterochaeta.* 1. Perithecium, × 45. 2. Ascus and paraphyses, × 285. 3. Spore, × 285.

4–9. *Sordaria alpina.* 4. Perithecium, × 45. 5. Ascus, × 285. 6. Spore, × 285.

7–9. *Hypocopra parvula.* 7. Perithecium, × 25. 8. Ascus, × 285. 9. Spore, × 600.

10–12. *Sordaria seminuda.* 10. Perithecium, × 45. 11. Ascus, × 285. 12. Spore, × 600.

13. Conidial stage of *Sordaria Montanesis*, × 600.

14–16. *Pleurage superior.* 14. Perithecium, × 55. 15. Ascus, × 285. Slightly swollen with spores somewhat disarranged. 16. Spore, × 600.

17. Apex of ascus of *Hypocopra equorum* from Montana.

18. Outline of apical structure of *Hypocopra equorum* after removal from the ascus. Nos. 17 and 18 drawn to the same scale. The dotted lines in No. 18 indicate the umen.

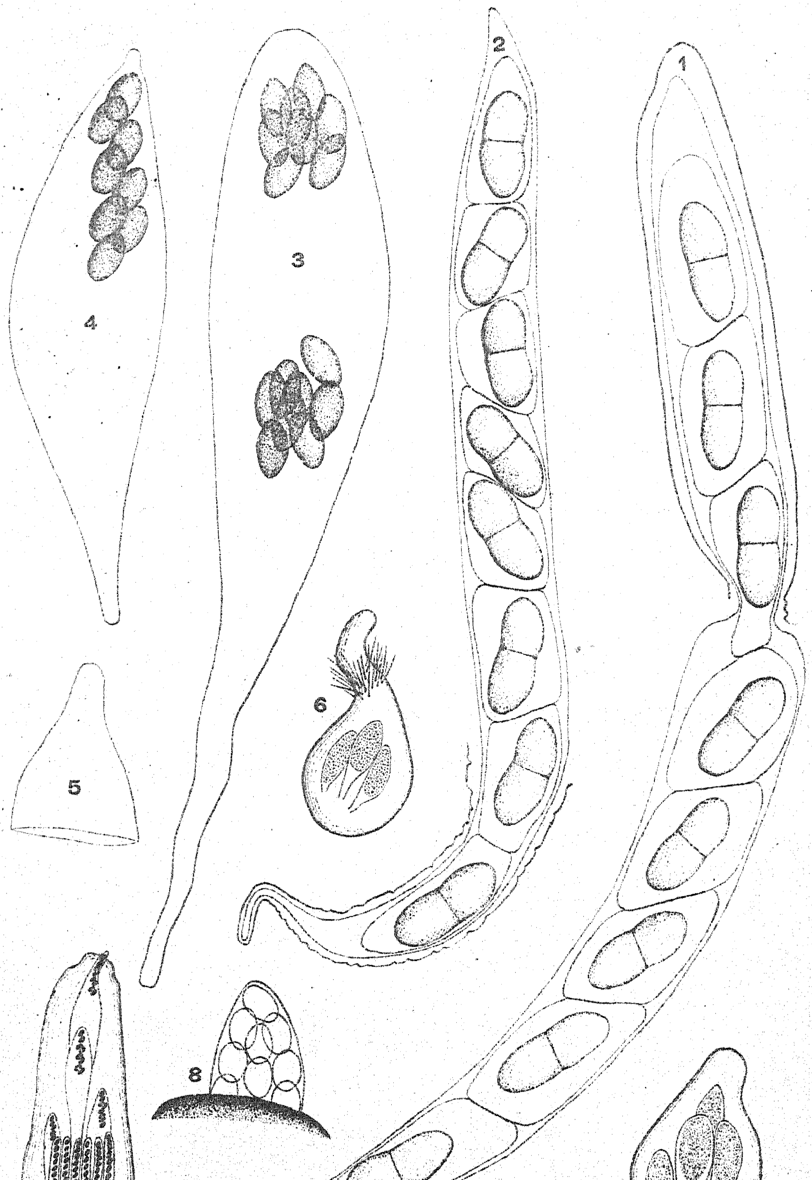
* Figures in this plate are not drawn to the same scale as the others.

INDEX

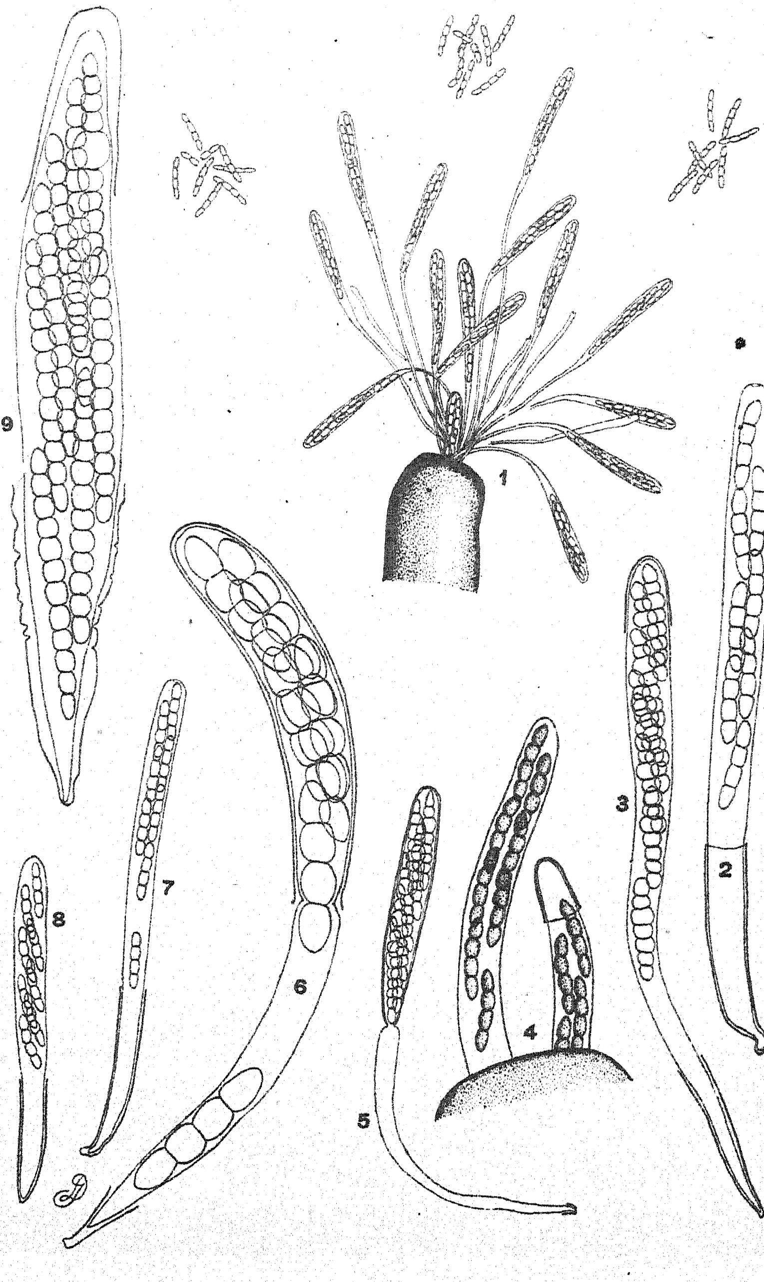
(The technical descriptions of the American genera and species are indicated by the **bold-face** numbers. Synonyms are in *Italics*.)

ERRATUM

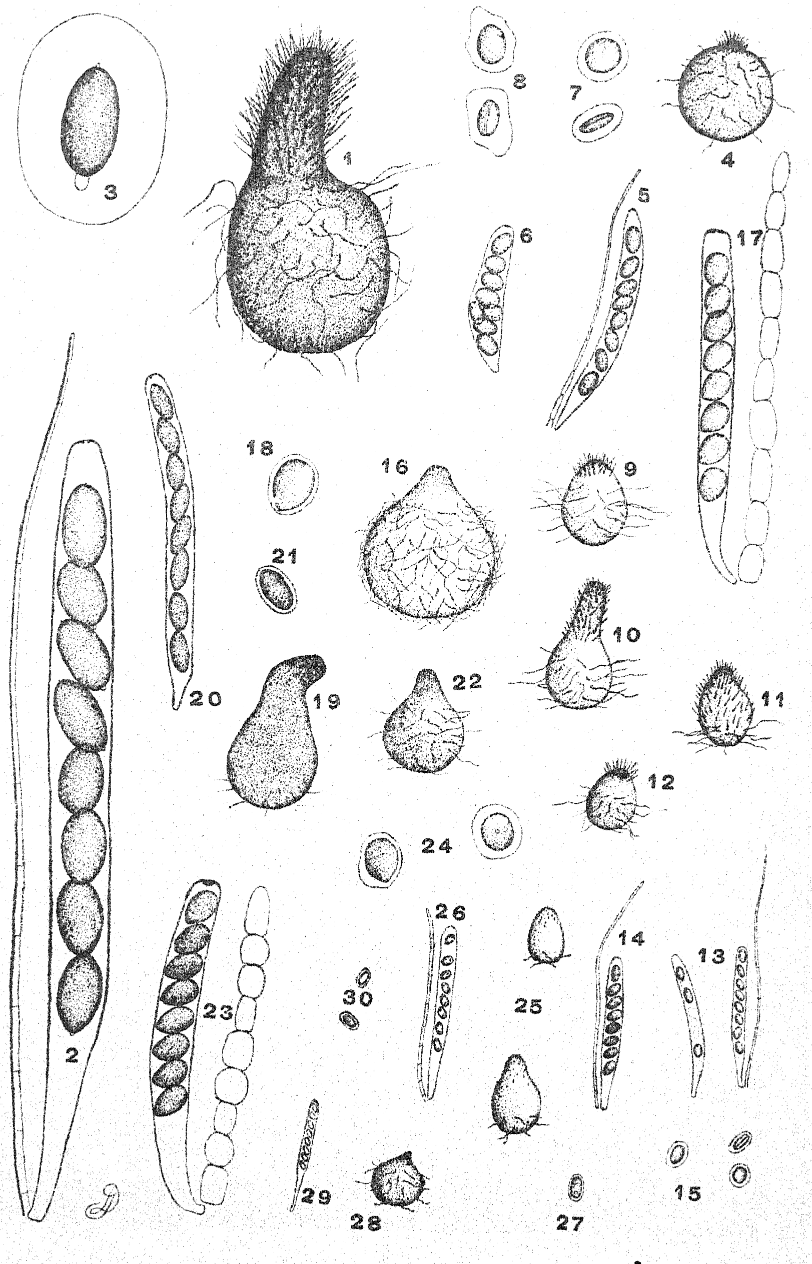
On pp. 9, 17, 100, 102, and 129 for *Delitschia Marshalii* read *Delitschia Marchalii.*



SPORE DISSEMINATION IN PLEURAGE AND DELITSCHIA



SPORE DISSEMINATION IN SPORORMIA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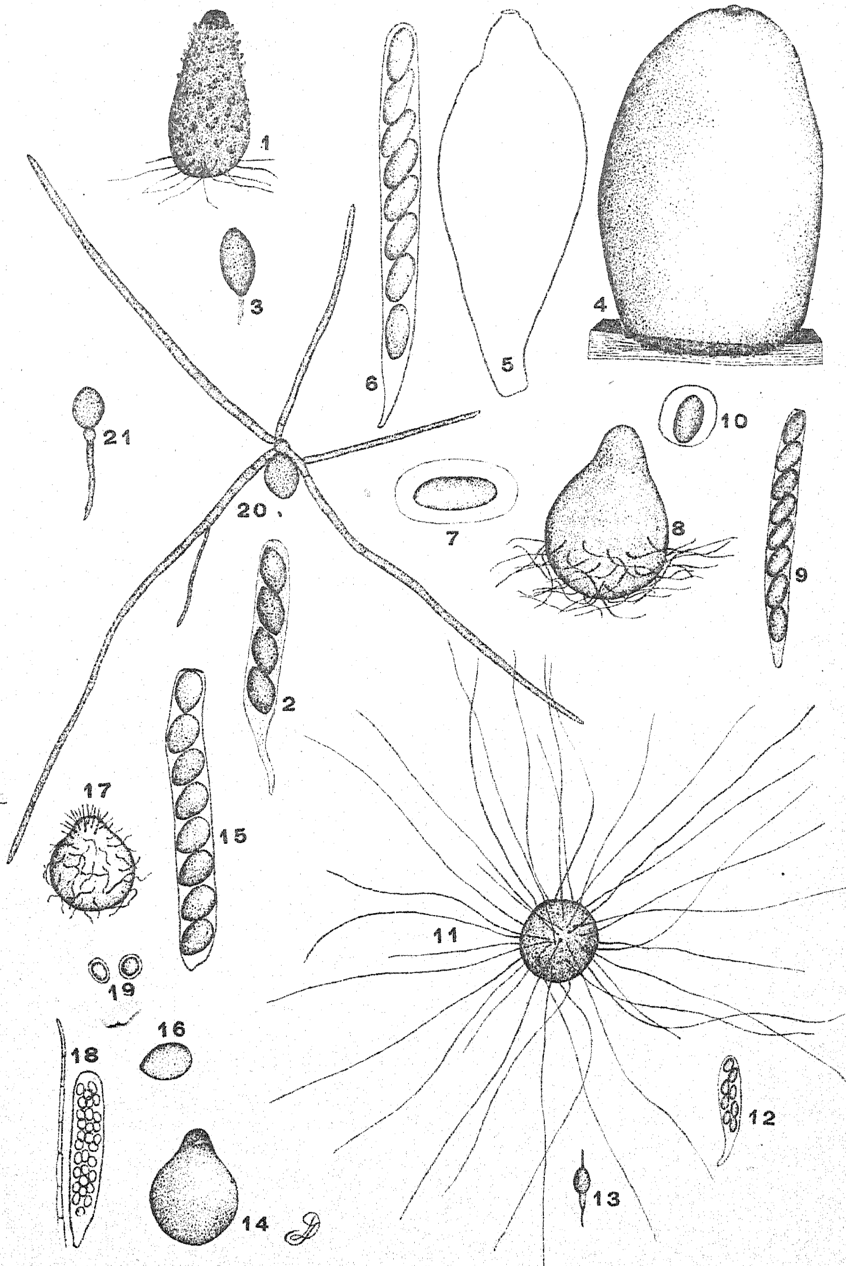
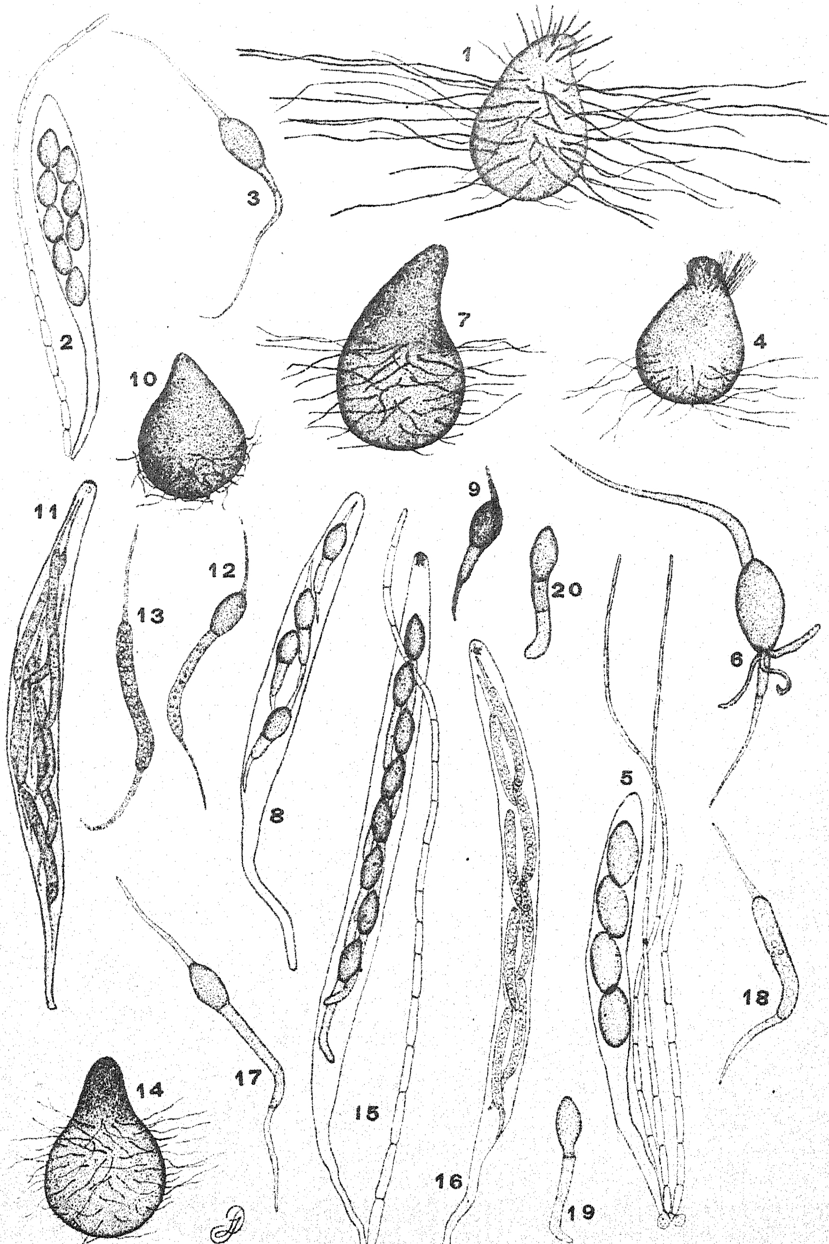
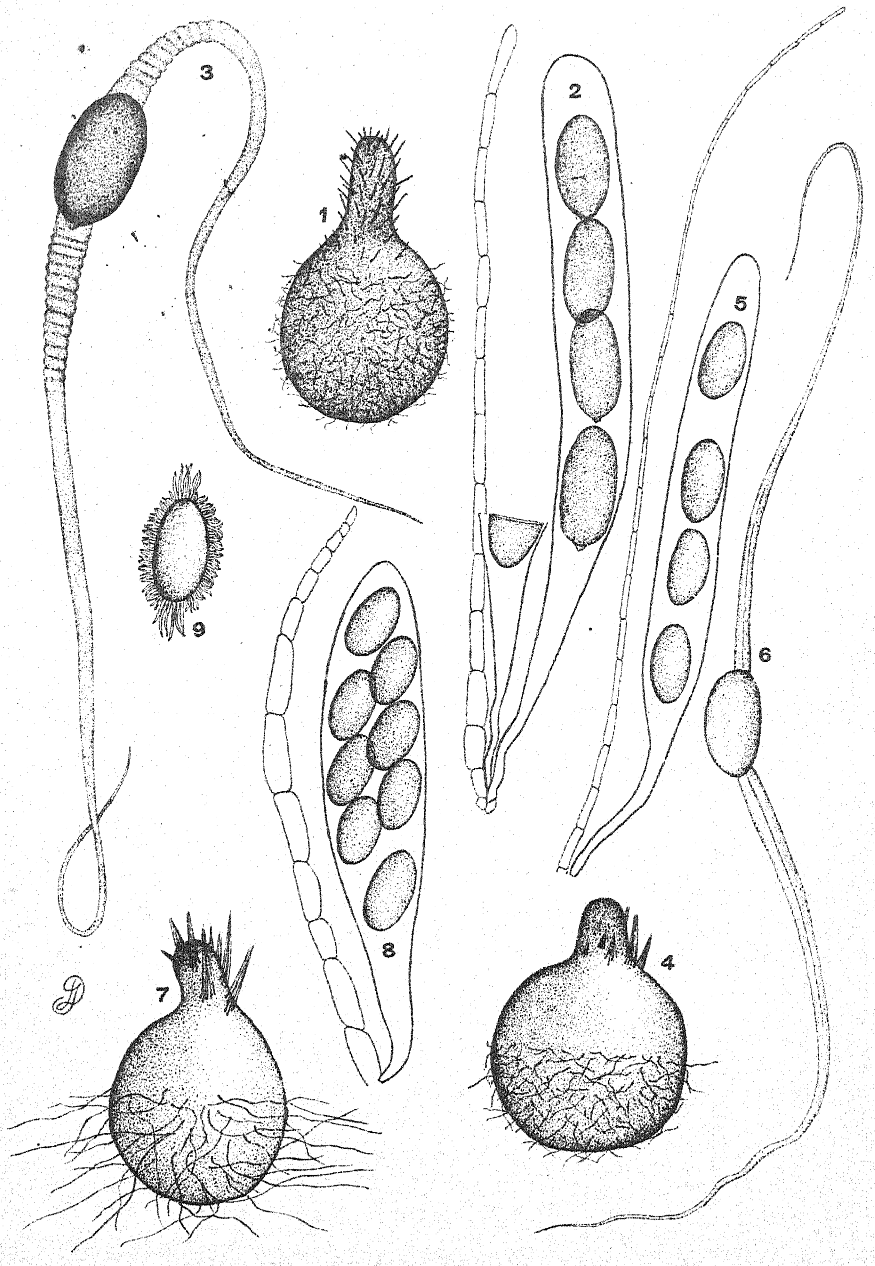
SORDARIA.



SORDARIACEAE



PLEURAGE



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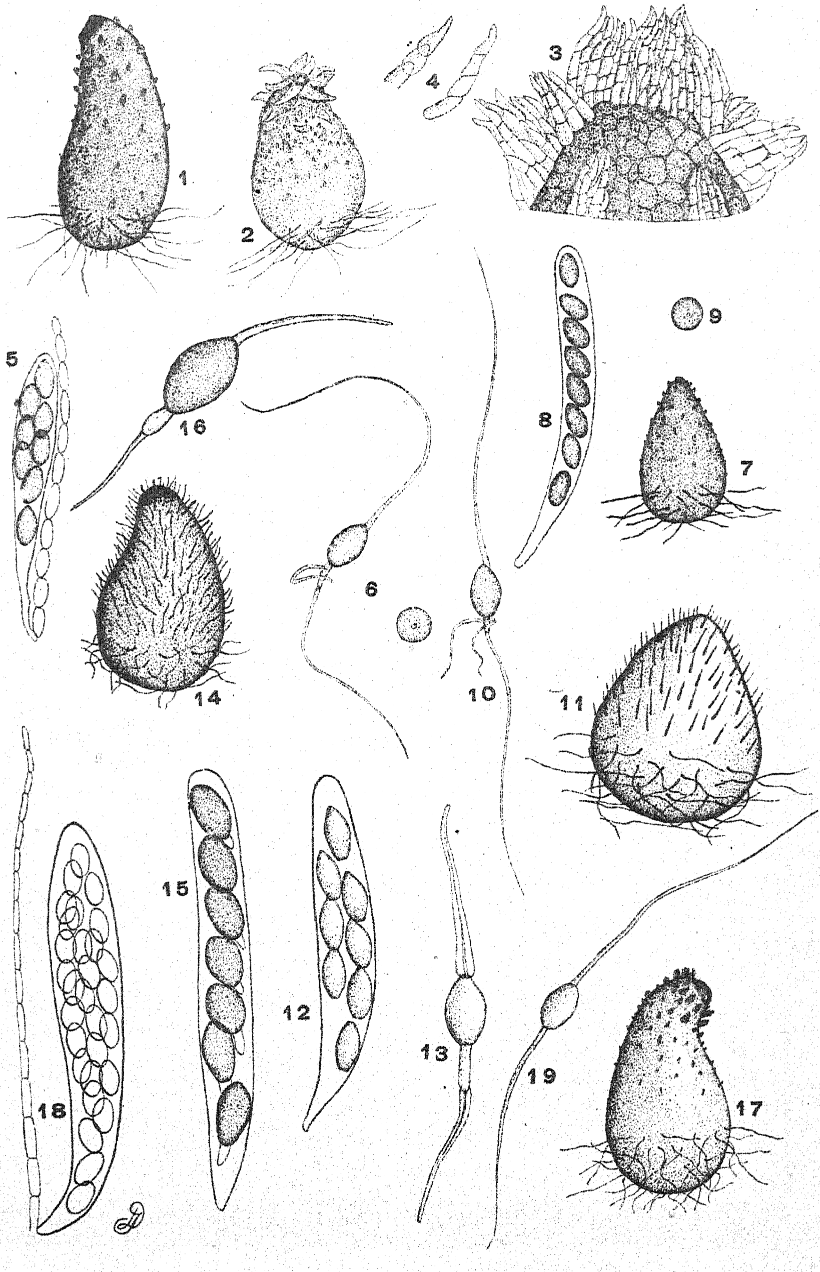

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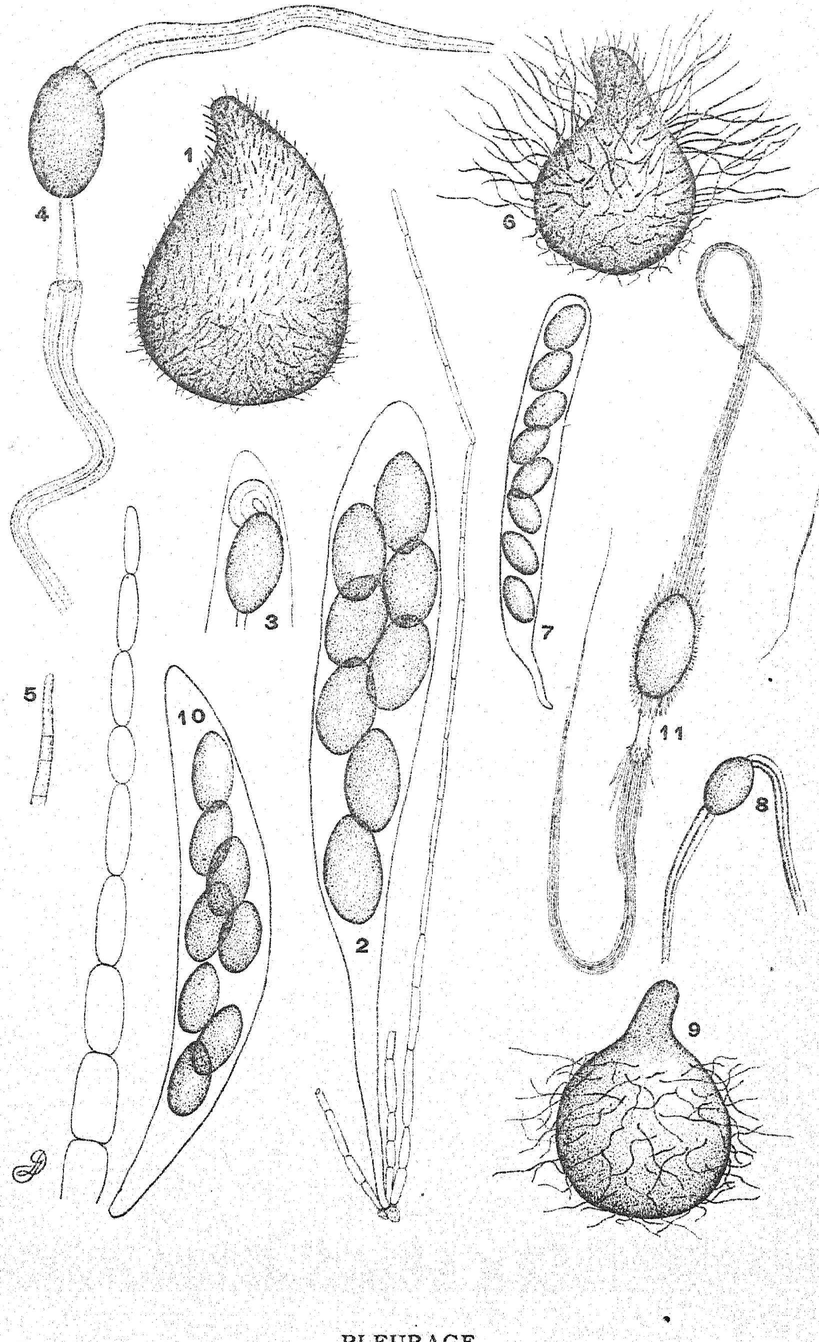

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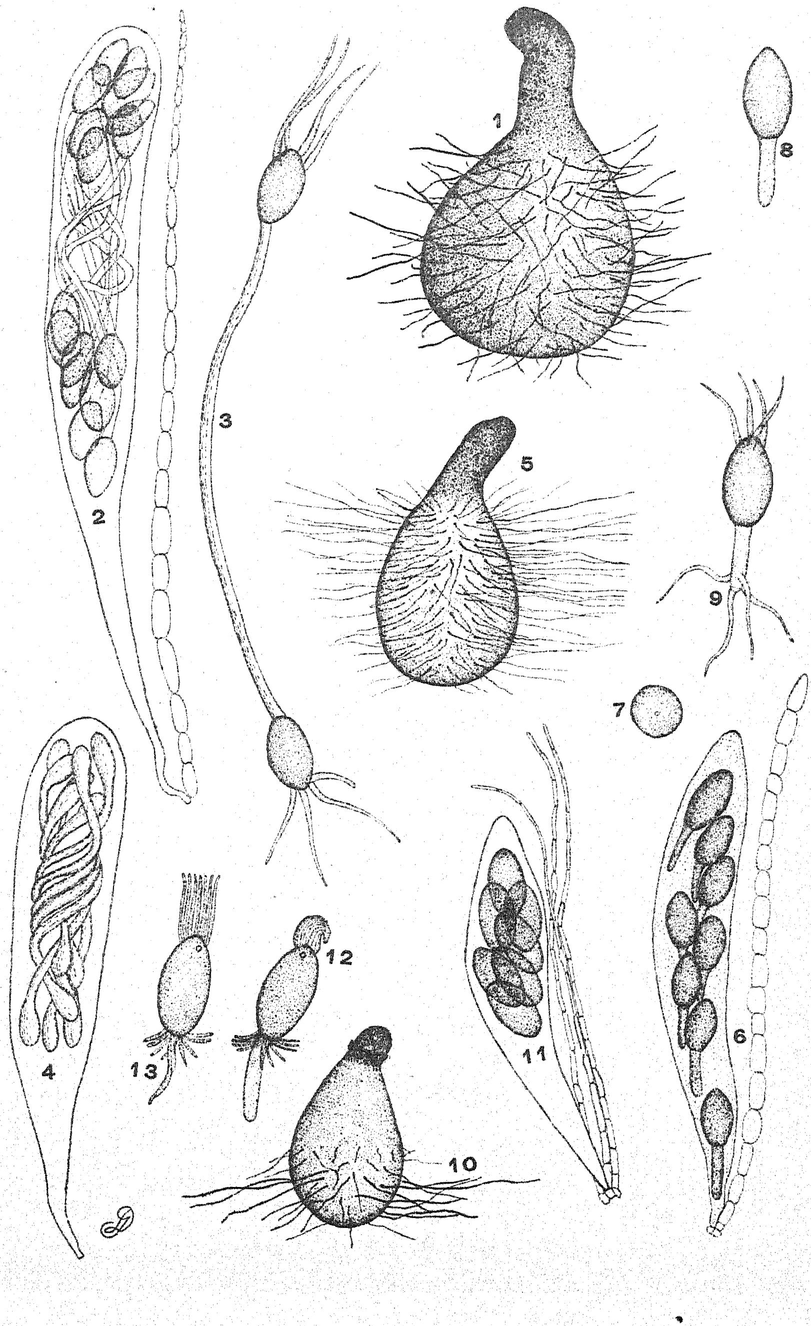

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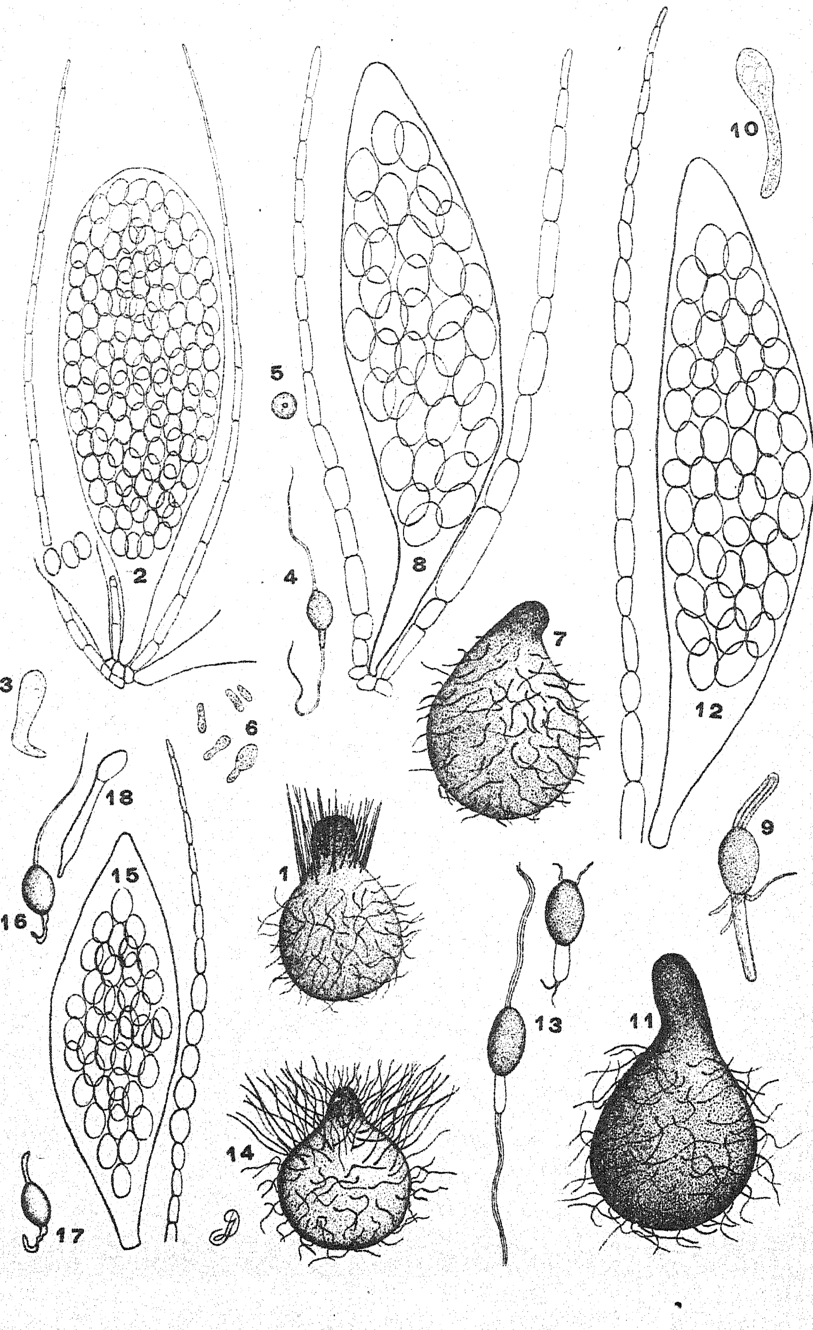

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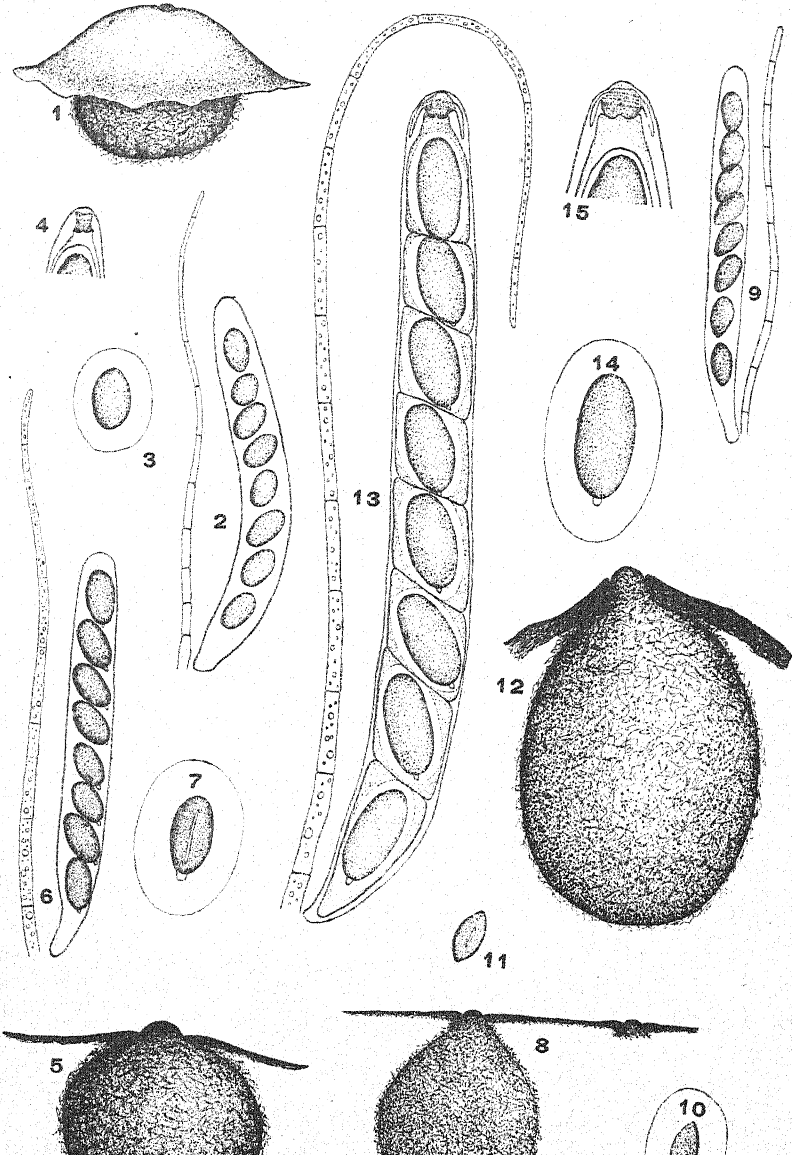

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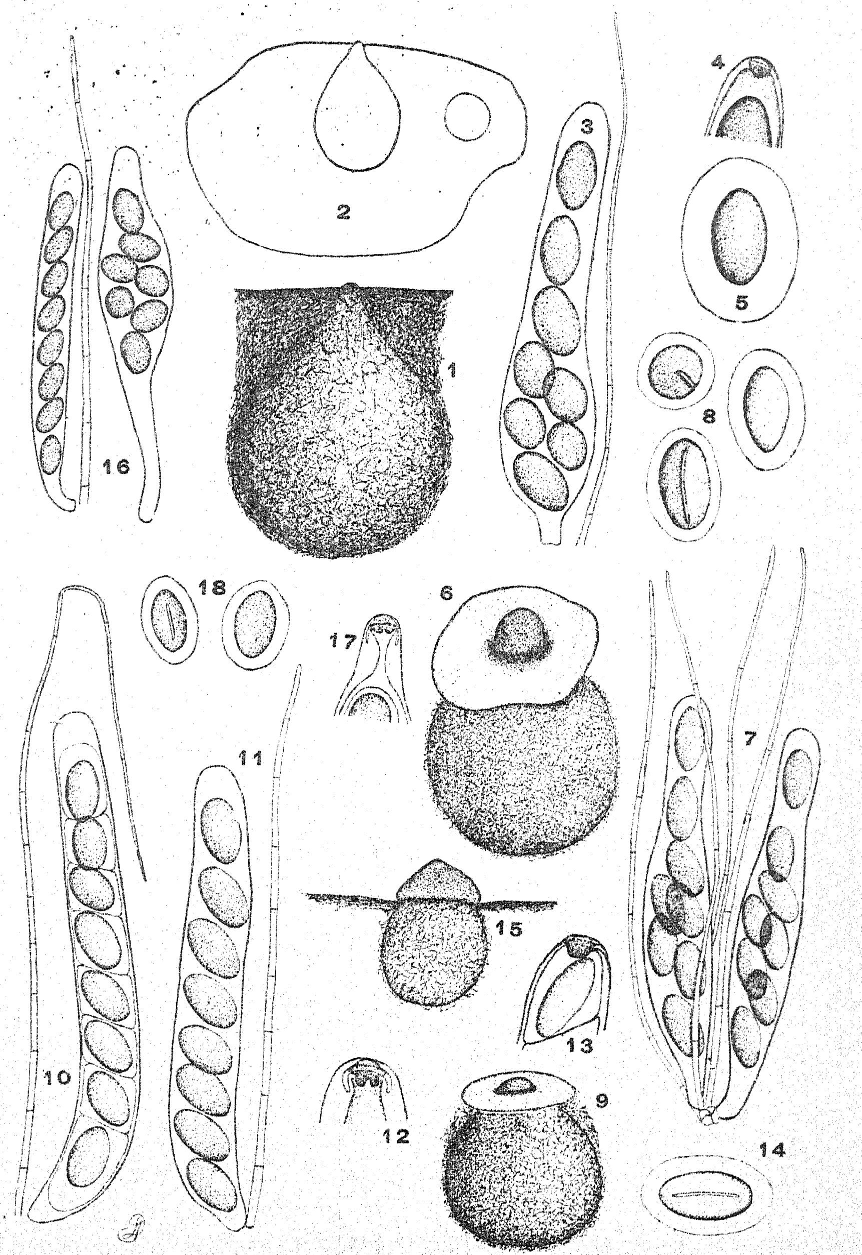

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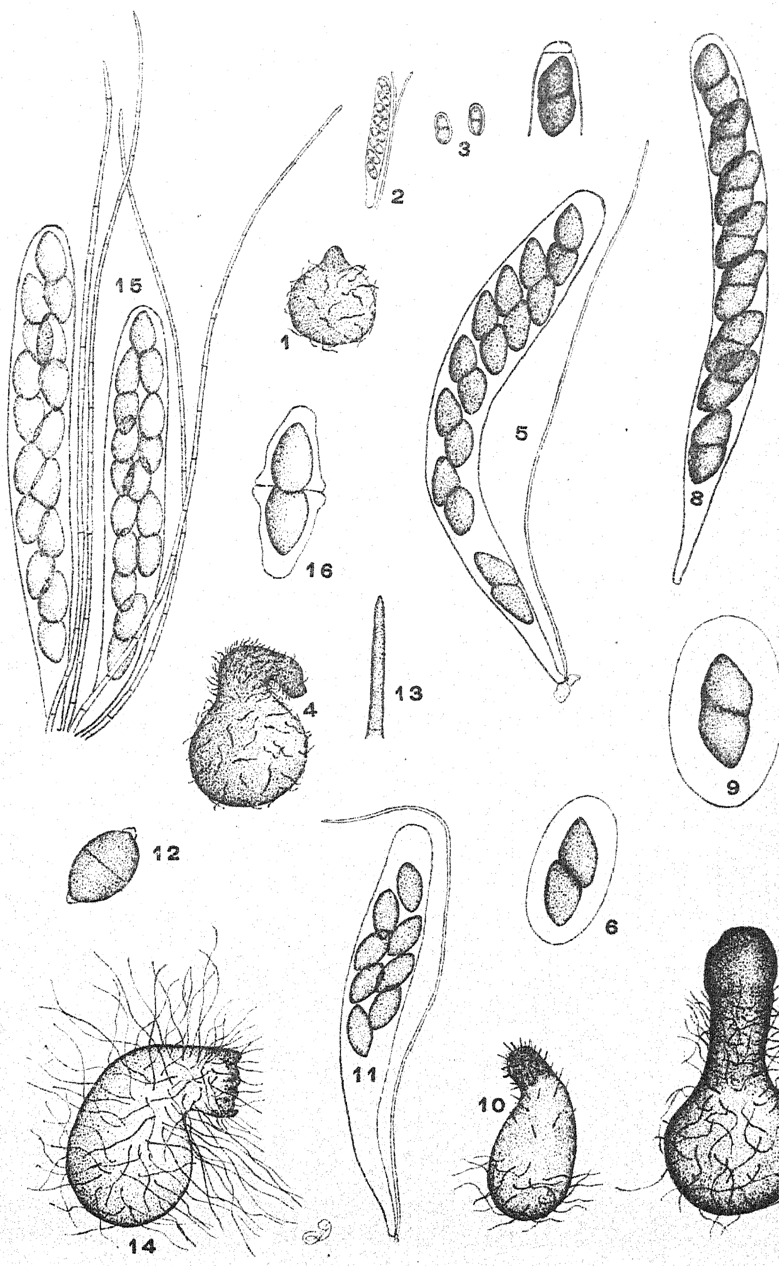
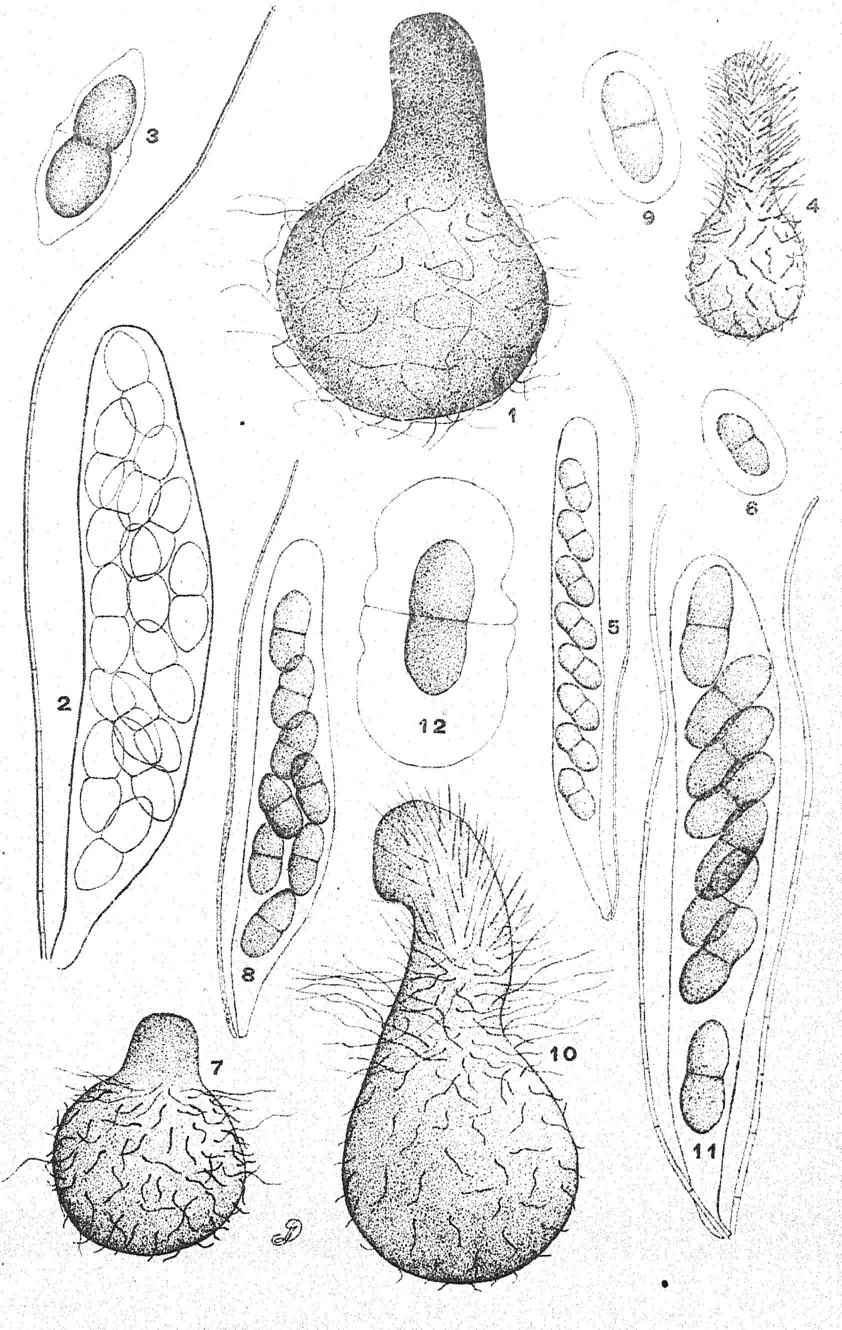


DELITSCHIA



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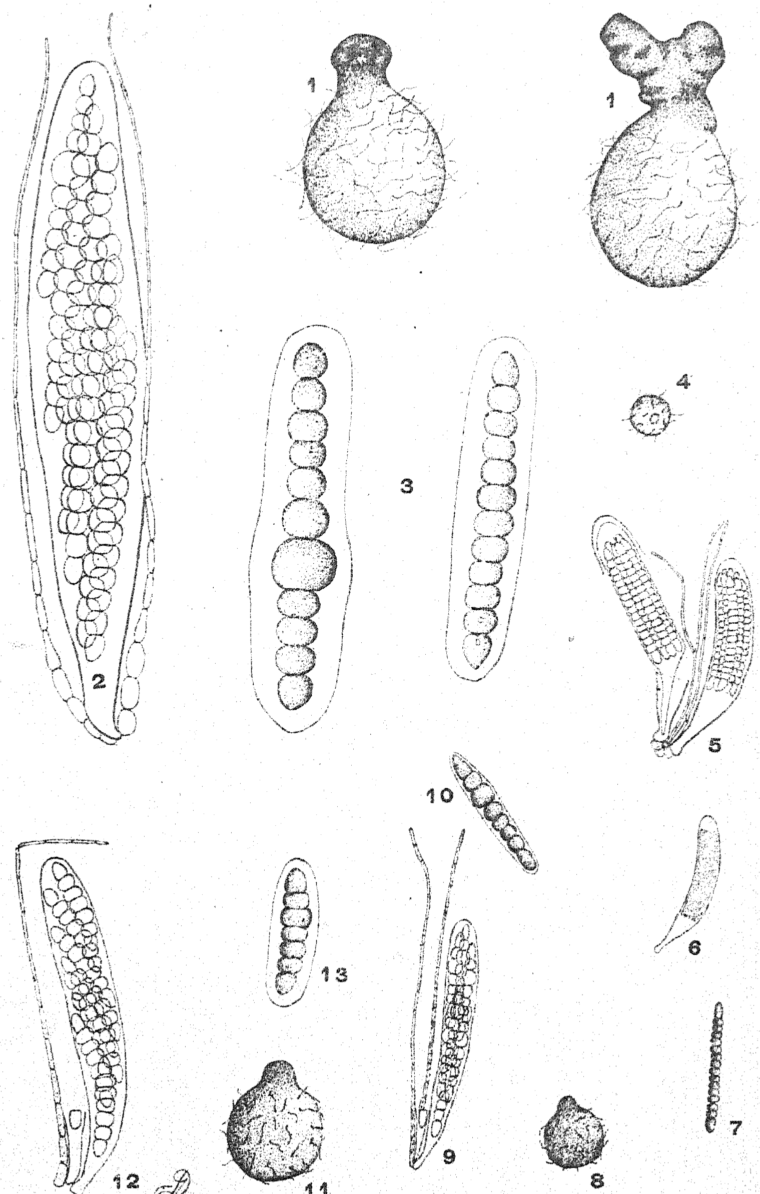
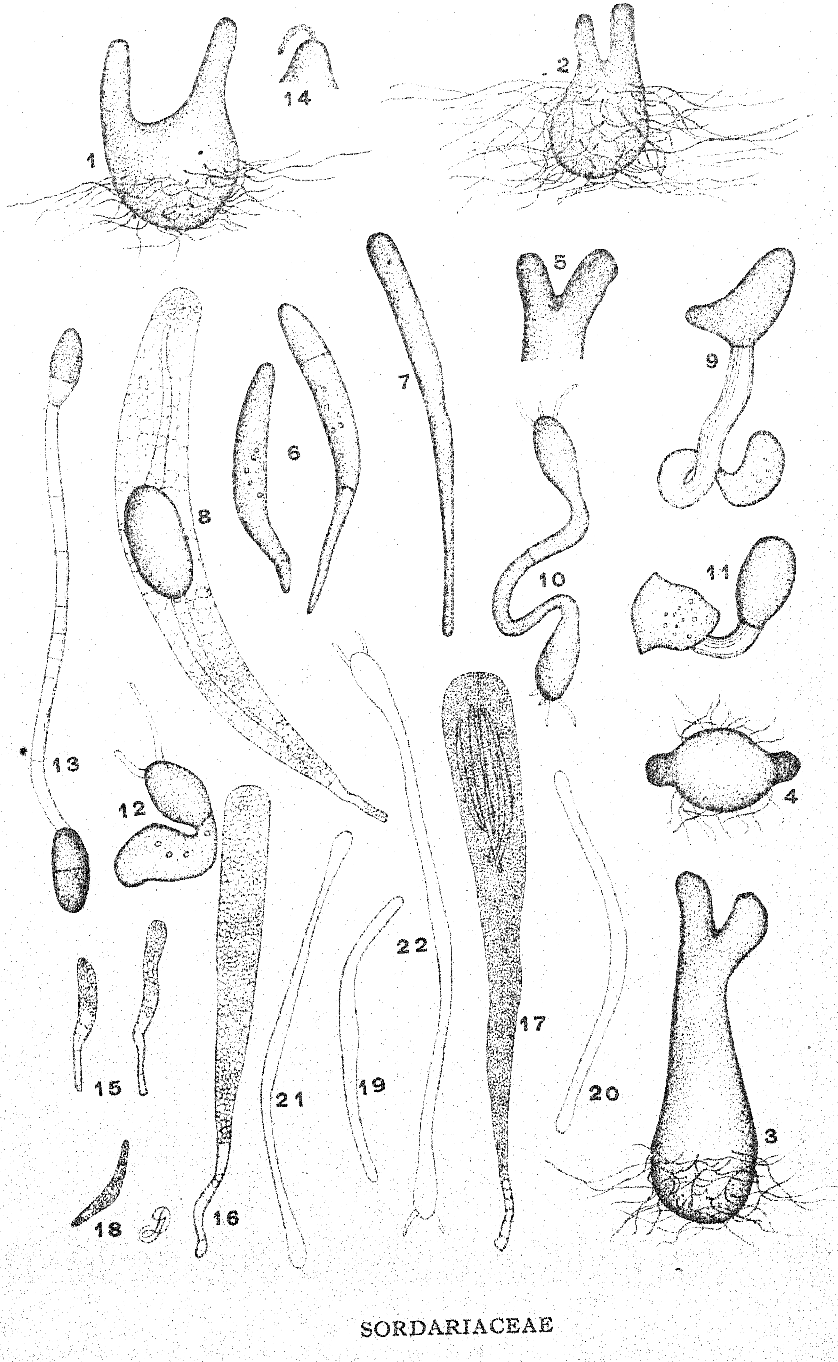
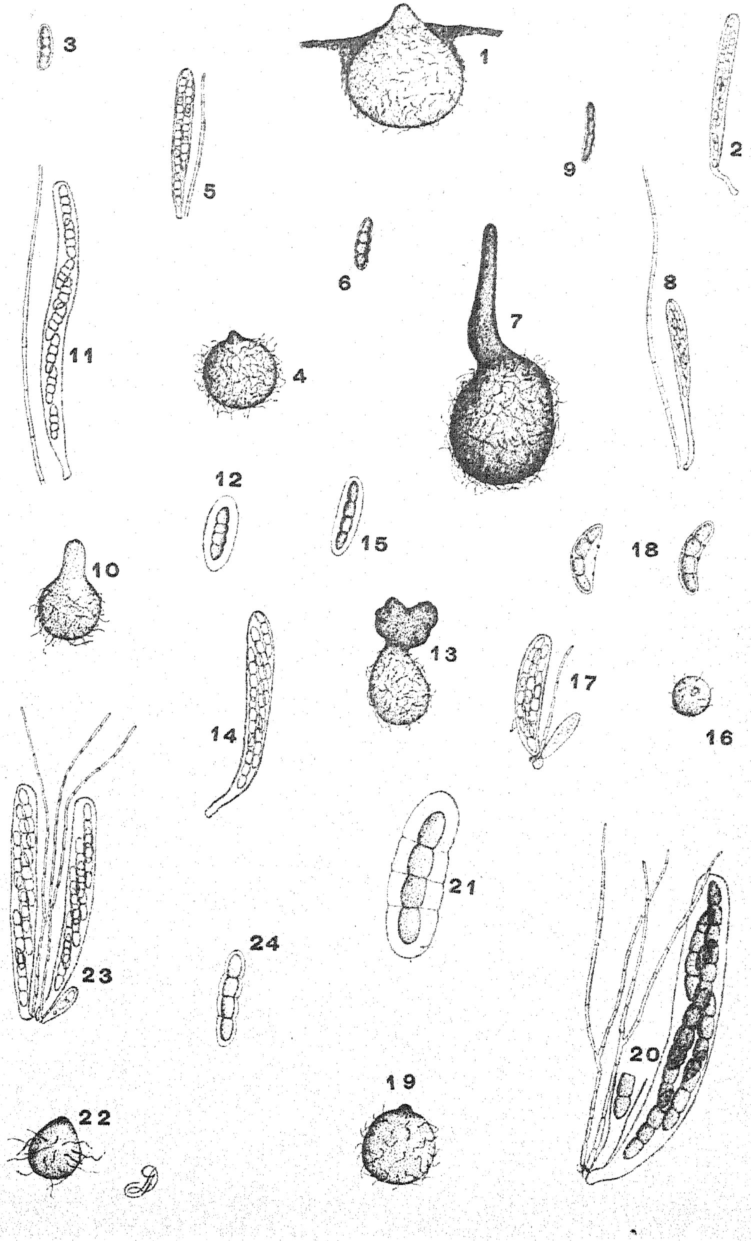


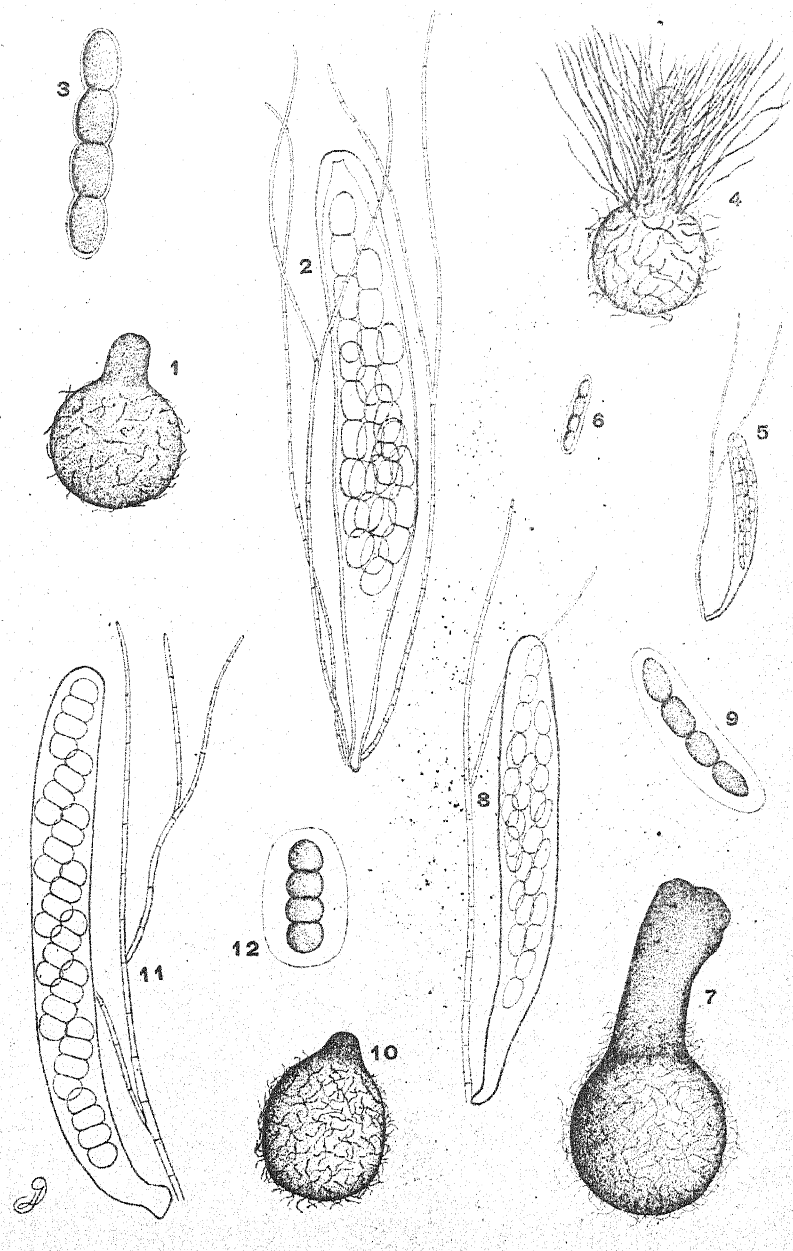
SPORORMIA



SORDARIACEAE



SPORORMIA AND SPORORMIELLA



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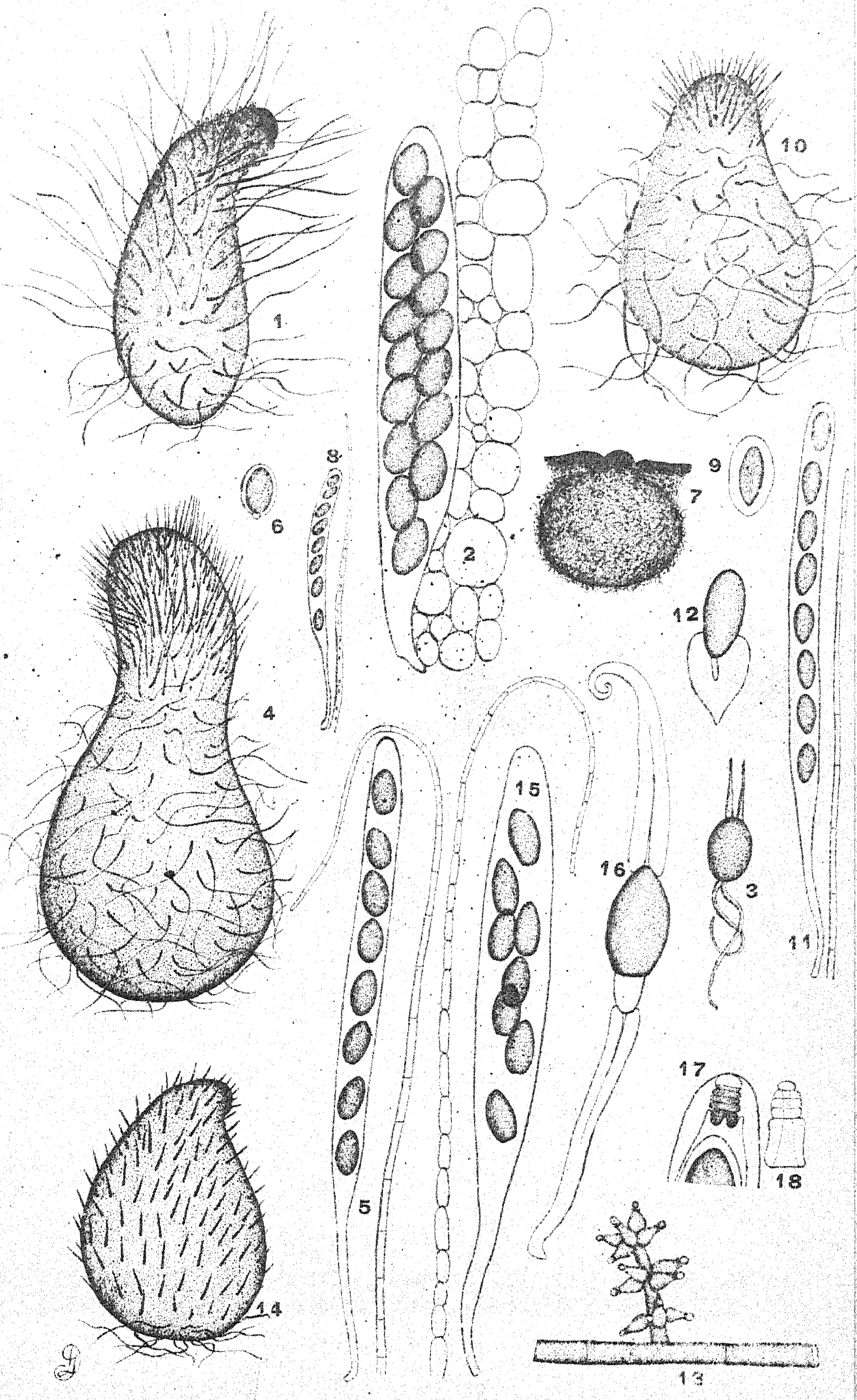

SORDARIA, PLEURAGE, HYPOCOPRA.

CONTENTS

The Ulothricaceae and Chaetophoraceae of the United States

By Tracy Elliot Hazen

Introduction

The purpose of the subjoined work is to furnish a contribution to the systematic knowledge of a group of our common but comparatively little known green algae.

This work was begun about five years ago. After a somewhat general study of the algae in field and laboratory, the conviction grew upon us that the species included in the two families here considered form the most generally neglected and misunderstood group of importance among the filamentous algae.

The chief reason for this state of affairs is, perhaps, to be found in the fact that in these groups specific and even generic distinctions, for the most part, do not rest upon fruiting characters as in other large groups (*e. g.*, in the Conjugatae and Oedogoniaceae), because there is too little diversity in such features, and also too little knowledge regarding them; but such distinctions must depend very largely upon vegetative characters. These vegetative characters are always more or less variable and this fact has given rise to two opposed tendencies, either of which leads to confusion. On the one hand, certain algologists have treated as distinct species or varieties (though generally without adequate description) all variations found, paying very little attention to the genetic connection which may exist among such forms; on the other hand, some writers have shown strong inclination to make wholesale reductions to varietal rank, without any sufficient understanding of the species so treated. The first tendency is best exemplified in the classical work of Kützing; the second began with Rabenhorst and has reached its extreme expression in the work of Hansgirg and De Toni.

The only American author who has attempted to give a complete account of the genera included in these two families is the late Rev. Francis Wolle. His work was a monumental task for a single pioneer, but, based as it was, almost exclusively on that of Rabenhorst and Kirchner, with little knowledge of exsiccatae, it

cannot, to say the least, be considered authoritative. Of course, in the fourteen years since the publication of The Fresh Water Algae of the United States, considerable progress has been made in Europe, notably in the separation of the genera and species of *Microspora* and *Conferva*, and of *Ulothrix* and *Stichococcus*. In other genera, *e. g.*, *Stigeoclonium*, practically no advance has been made. In this country, very little critical work has been done, though the issue of a considerable number of specimens in exsiccatae, chiefly in the series of American Algae of Miss Tilden, and the Phycotheca Boreali-Americana of Collins, Holden and Setchell, has paved the way for such work and in some cases made it necessary. The well-prepared specimens of confervoid algae in the latter series have, for the most part, the weight of Professor N. Wille's determination. Any treatment of these groups, to be worthy of confidence, must be supported by a knowledge of recent literature not only, but by a good degree of familiarity with the exsiccatae and the older literature, particularly the works of Kützing. This element appears to have been lacking in the recent work of some western investigators.

One great source of confusion has been the incorrect determination of specimens, particularly manifested in the practice of forcing a given form into a certain species, or in other words, stretching a specific diagnosis so as to include specimens varying in what is believed to be unimportant details, in order to avoid burdening literature with new species. Such a policy is always pernicious in its tendency, for in a great number of cases the species in question is misinterpreted, and its characters changed so that uncertainty results, both as to the definition of the original species, and also as to the character of the form identified with it. In cases of doubt it is much less confusing to make new species, and when a reasonably clear diagnosis of a new form cannot be furnished, it should be suppressed.

Method of Study

In general the method pursued in preparation for this paper has been inductive; the policy has been, first, to make as many collections as possible, and by careful observation and comparison, to decide upon the distinctness of the different forms, and then to

identify them, as far as possible, with previously described species, paying especial attention to the historical interpretation of the latter.

One great lack in the study of such forms as those under consideration, is the want of correlation of observations. Here, more than in higher forms, different phases of the same plant are likely to be identified as different species ; again, because of a supposed resemblance between different forms, or, because two or more really diverse filaments are found growing together, they are associated under one name, without any proof of connection.

In order to obviate this difficulty, and to place species definition upon a firmer basis, we have made as thorough a study as possible, considering the large number of forms treated, of life histories. Our rule has been to make collections repeatedly from the same station, or rather from several stations, as well as to follow such collections by laboratory observation.

Extended culture is a difficult matter in the case of algae like these which generally grow in rapidly running water. Such plants usually develop differently in a stagnant culture. To fit up a laboratory with a sufficient number of tanks supplied with fresh water would be expensive and not always feasible. A method, which has proved to be of value in certain cases, might profitably be employed further. We have sometimes placed fresh specimens in glass cylinders (*e. g.*, large bottles with the bottoms knocked out), covered both ends with thin muslin, and anchored them near the surface in a running brook. Frequent examinations of such cultures may easily be made. Some plants do not take kindly to even this sort of captivity, perhaps because the change in the composition of the water is not beneficial ; others may be successfully kept until after important observations have been made. Many species have refused to disclose their reproductive processes even though carefully watched, but some advance in this direction has been made.

As a rule, new species have not been proposed except in cases where repeated collections from the same stations have admitted of no doubt regarding the validity of the form in question. In one or two instances very marked forms have been described as new upon the strength of only one collection. Many specimens ap-

pearing to be simply young forms have been laid aside altogether until further light on them can be obtained.

A great effort has been made to see all literature bearing upon the families treated. Nearly all important works were to be found in the combined libraries of Columbia University and the New York Botanical Garden, or were obtained through the liberality of the latter institution. Two or three articles not otherwise obtainable were seen at the libraries of the Philadelphia Academy of Sciences and Harvard University.

All available exsiccatae have been diligently examined, including the following series: Areschoug, Algae Scandinavicae Exsiccatae; Desmazières, Plantes Cryptogames de France; Erbario Crittogamico italiano, ser. II; Hauck & Richter, Phykotheca Universalis; Kryptogamae Exsiccatae; Kützing, Algarum aquae dulcis Germanicarum Decades (part only); Rabenhorst, Die Algen Sachsens, Die Algen Europas; Wittrock & Nordstedt, Algae aquae dulcis exsiccatae; Collins, Holden & Setchell, Phycotheca Boreali-Americana; Farlow, Anderson & Eaton, Algae Exsiccatae Americae borealis; Tilden, American Algae. Naturally many of these dried specimens are very unsatisfactory, but an attempt has been made to mention all American specimens where their character could be determined with a fair degree of certainty.

A pilgrimage was made to Bethlehem, Pa., where, through the kindness of a son of the late Mr. Wolle, we were permitted to see the herbarium which formed the basis of The Fresh Water Algae of the United States. Microscopical study however, was made only in the case of the Ulothricaceae, which could be examined without danger of marring the specimens.

The specimens collected by Schweinitz in North Carolina preserved in the Torrey herbarium of Columbia University are for the most part so old or so poorly preserved as to be unidentifiable, but the collection is of less taxonomic importance than historic interest, as most of Schweinitz' names were published only in J. W. Bailey's lists without descriptions.

Of specimens from miscellaneous collectors, comparatively few have been seen, so that our work is based very largely upon our own personal collections.

In our lists of specimens under different species, the name of the collector is given in parenthesis, except in the case of our own collections, which are designated simply by a number enclosed in parenthesis. In certain cases where specimens have not been seen, records of collections have been noted in quotation marks. Exact dates have been given only in the case of specimens of other collectors. All our own collections noted have been made since September, 1897, and as there is comparatively little variation from year to year, only the month of collection is noted. Types of all new species, and duplicates of a large part of the material on which this study is based, will be deposited in the Herbarium of Columbia University at the New York Botanical Garden.

Often a better notion of a species is given by an illustration than by a very detailed description, but with illustrations so much depends on the variations of the plants and the individuality of the author, that it is a matter of convenience to have as many drawings as possible made on one system, by one person. It has, therefore, been our attempt to furnish figures of representative specimens of all forms of which fresh material has been seen. All our drawings have been made with the use of the camera lucida, and at uniform scales of magnification within the limits of a genus. For all the Ulothricaceae, *Microthamnion*, and the Herposteireae, a combination of Leitz ocular 3 and objective $\frac{1}{12}$ oil immersion was used; for *Myxonema*, ocular 3 with objective 7; for *Draparnaldia*, ocular 1 with objective 7. The drawings thus made were reduced one half in reproduction.

In nomenclature, the Rochester code has been followed generally, though perhaps not with absolute rigidity in the case of one or two generic names.

The matter of generic types has demanded considerable attention. It has been our aim in all cases to use the oldest admissible generic name that can be anchored to a definite type species; that is, the species placed first under the original description of a genus has been considered the type, and in accordance with the validity of the genus as thus founded, it has been retained or discarded.* This method has been followed because it is our con-

* For a more extended discussion of this subject, see Mem. Torrey Club, **6**: 250–252. 1899.

viction that it is the only course based on rational principles and offering a fair hope of attaining the goal of stability. How little disturbance this method makes in these groups is seen in the fact that it has appeared necessary only in two cases to displace the names current among modern algologists, namely, *Conferva* and *Stigeoclonium*.

Very few varieties have been listed, because experience has proved that many of those in current use are either mere growth forms of the species with which they are associated, or are wrongly associated with the species. Mr. Wolle was in the habit of listing all the varieties given by Rabenhorst and Kirchner, without reference to their actual occurrence in this country. These have been repeated by De Toni as American forms, and thus confusion has arisen.

A sharp distinction between variety and forma, in the technical sense, has been here understood: by the term variety, better called subspecies, is indicated a form which is well-marked in relation to the species and fairly constant in character; by the term forma we have designated a form which is sufficiently well marked to demand recognition, but which is regarded as probably only a growth state of the species.

The limits of the two families treated are drawn practically on the lines laid down by Wille in Engler & Prantl, Die natürlichen Pflanzenfamilien. The chief departures from that work are the relegation of *Trentepohlia* and *Acroblaste* to a separate family, because of their specialized sporangial cells, and the removal of *Microthamnion* from this group to what is clearly its proper place, among the Chaetophoreae. As a matter of convenience we have also arranged the microscopic genera of the Chaetophoraceae in a separate tribe, the Herposteireae, taking the name from the most highly developed of the group, a name which is at the same time most suggestive of the creeping habit of all the forms.

It is very probable that the position taken by Borzi ('89), Bohlin ('97), and Wille ('01), in removing *Conferva* (= *Tribonema*) from the Ulothricaceae to a separate family and order in close affinity with the Ophiocytiaceae, is well grounded; for the present convenience, h wever, of American students who have not distinguished this genus from *Microspora*, it has been temporarily retained in its old position.

METHODS OF PRESERVATION

Where cell characters are among the chief requisites for the determination of species, as is the case with many of these plants, specimens preserved on paper, according to the usual method with seaweeds, are, to say the least, extremely unsatisfactory. Indeed, one is sometimes tempted to discard such methods altogether. Nevertheless, this method is, in certain respects, of considerable value, and should be generally, though not exclusively employed; paper or mica mounts are most convenient for the herbarium to show distribution and form in the mass; furthermore, they furnish a record which is likely to be permanent, while slide mounts are more liable to deterioration or accidental injury.

For purposes of accurate study, however, and for convenience of comparison of a large number of specimens, it is necessary to have material fixed and mounted on slides, or at least preserved in bottles. Of the more elaborate methods, we have attained greatest success by fixation in Flemming's stronger solution, followed by staining in iron haematoxylin, with the addition of a light counter-stain of Congo red. Great care is necessary to prevent plasmolysis and distortion.* This method requires too much time if one desires a large series of one species for comparative study.

The following simple method has proved of great service; enough material for two or three mounts is dropped into a small bottle of Flemming's stronger solution for a few seconds or moments (the length of time varying with the delicacy of the species), then rinsed hastily, arranged on slides, and covered with a few drops of two to five per cent. solution of chromic alum; the cover-glass is laid on, the superfluous fluid removed with filter or blotting paper, and the mount sealed with colorless marine glue. Preparations made in this manner are somewhat liable to deterioration because of defective sealing, but enough mounts may

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* The most useful discussion of this and similar methods is to be found in the articles by C. J. Chamberlain, Journ. Applied Mic. **1**: 156. 1898; **2**: 506, 543. 1899, and in the more elaborate work of F. Pfeiffer von Wellheim, Zur Präparation der Süsswasseralgen. Jahrb. wiss. Bot. **26**: 674–732. 1894, and Beiträge zur Fixirung und Präparation der Süsswasseralgen. Oesterr. Bot. Zeit. **48**: 53–59, 99–105. 1898. (Translation in Bull. Soc. Belg. de Mic. **24**: 22–103. 1898.) See also a note by Charles Thom, Bot. Gaz. **24**: 273. 1897.

easily be made to give reasonable assurance of preservation of the specimen. While these preparations are not always as well fixed as those made by more elaborate methods, they are very satisfactory for systematic purposes. They even have certain advantages and on the whole are perhaps more useful than more carefully prepared mounts ; the brief subjection to the osmic acid often renders the nuclear and chromatophore characters sufficiently clear, and the natural appearance of the cell-wall is better preserved than in material subjected to longer fixation. Furthermore branched forms can be arranged in a much more life-like manner, and delicate setae are less likely to be lost, than when specimens are passed through many washings.

For preservation in bulk, dilute formalin often gives fair or good results. A better medium, because of its more truly fixative power is Pfeiffer's solution of equal volumes of formol, pyroligneous acid and methyl alcohol. This is convenient for field use, as only a small quantity is required, and specimens may be fixed and preserved for months in it. At any convenient time the material may be removed and, after washing, preserved for staining in glycerine or alcohol. Specimens may even be mounted on the slide in chromic alum directly from this fixative, and they will show a good degree of differentiation.

DISTRIBUTION

No very extended account of the distribution of these plants can be given at present. The printed lists in the various local catalogues are too meagre to be of much value, even if the determinations could be considered reliable. Mr. Wolle's collections, though comprehending specimens from widely separated regions, furnish no very definite contribution to our knowledge of distribution, for a large part of his labels state only the habitat and not the locality in which the specimens were collected. It is to be presumed that most such specimens were collected in the vicinity of Bethlehem, Pa. No general request for specimens from botanists of different sections has been made, because of the difficulty of positive determination of dried specimens.

Our personal collections have been made largely in Greater New York and its immediate vicinity, extending to the palisade

region of New Jersey; lesser collections have been made in Vermont, eastern Massachusetts and Connecticut. Sufficient time has been spent in these different regions to warrant a rough comparison. The region about New York appears to be by considerable the richest in number of species. The region about Boston possesses a good number of species, but brief visits at different seasons have made it appear doubtful if even a thorough exploration would disclose as great variety as is to be found around New York. Litchfield county, Connecticut, is a disappointing region. The very numerous streams would lead one to expect to find a large number of forms. However, during a trip across the county in September very few Chlorophyceae except *Spirogyra* and *Oedogonium* were found; in the spring months some very interesting forms were collected, but no great number could be obtained.

In Vermont, from summer explorations in the vicinity of Burlington and Grand Isle, and investigations during more than a year at St. Johnsbury, we have been forced to the conclusion that there is no great number of forms of common occurence. Possibly more might be seen in the western part of the state in the spring, but the pools and streams there are much less affected by the summer heat than those about New York, and consequently one would not expect a great difference between the spring and summer algal floras. Indeed, *Draparnaldia*, which disappears entirely from New York streams during the summer has been found at St. Johnsbury in August, so that a larger number of species of *Myxonema* also might be expected.

In the vicinity of New York so many of the streams are nearly or quite exhausted during the summer months that one would not expect at that season to find many of these pure-water loving plants. Nevertheless even during the hottest days in the fountain basins and watering-troughs there is a sufficient abundance of material to keep one busy in collecting and comparing different forms, particularly of *Myxonema*, and it is hardly to be supposed that the whole number of these summer forms is here treated.

It is to be regretted that there has been necessity for assuming so critical and perhaps apparently pugnacious an attitude toward the work of others, and in particular Americans, but possibly

their work might have had a more trustworthy character if it had been dealt with more critically during its progress. Indeed, we have been keenly sensible of the lack of criticism upon our own work. It is, perhaps, too easy to find fault with the work of others, and not so easy as one could wish to make great improvement upon their work. The meagerness of the older and of some recent descriptions where the only important characters are size and shape of cells, often makes it a matter of great difficulty to determine species. We have endeavored to emphasize cytological and especially chromatophore characters as much as possible, but often one cannot find important distinctions of that nature, and is forced to rely largely on cell-measurements to separate species which, after careful observation, he is convinced are distinct. It has been particularly disappointing, in the attempt to make synopses of species, to find that even now the use of cell-measurement is one of the most convenient means of separation and has been resorted to in a much greater degree than had been expected.

It is a pleasure to make grateful acknowledgment of the encouragement and counsel, as well as sympathetic companionship in laboratory and field, of Professor L. M. Underwood and others of the Botanical Department of Columbia University, and to express our thanks to those who have furnished specimens for study, and given guidance in collection, notably Mr. F. S. Collins, Mr. Isaac Holden, Professor G. E. Stone, Dr. David Griffiths, and Dr. M. A. Howe.

ORDER CHAETOPHORALES *

Family **ULOTHRICACEAE**

The thallus consists normally of a simple, unbranched, filament of uninucleate cells, which are all (the basal cell only, when

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*This new name for the order which has been known as Confervales is proposed by Wille (Nyt Mag. for Naturvid. 39: 1–22. 1901), because the latter name is rendered unsuitable in consequence of the removal by recent authors of the genus *Conferva* from the Ulothricaceae. The name of the order Confervales Borzi, including the new family Confervaceae, the Ophiocytiaceae, etc., is confusing in view of the older order Confervales, and ought, moreover, to be changed because the genus *Conferva* Lagerh. should be known as *Tribonema* Derb. & Sol.

Professor Wille appears to take a backward step in the paper cited, in that the Ulothricaceae are there placed under the Ulvaceae. The two families are closely related, and possibly almost overlap, but it seems more convenient to retain both.

present, excepted) capable of division and of transformation into sporangia. Each cell contains one band-shaped or reticular, or one to several disk-shaped chromatophores. Vegetative reproduction by breaking apart of the cells to form new filaments. Asexual reproduction by means of zoöspores which germinate immediately or after a period of rest, by akinetes, and by aplanospores. Sexual reproduction through isogamous fertilization or conjugation of gametes of similar size and character.

Synopsis of Genera

Filaments attached; chromatophore a homogeneous, zonate band, with one to several pyrenoids. I. ULOTHRIX.

Filaments not attached; chromatophore a parietal disk or plate, with one pyrenoid. II. STICHOCOCCUS.

Filaments generally not attached; chromatophore granular, covering more or less completely the whole cell wall, containing starch but no pyrenoids. III. MICROSPORA.

Filaments attached only when young; chromataphores several, disk-shaped, without starch. IV. TRIBONEMA.

With the exception of *Ulothrix* and *Stichococcus* the genera of this family are not closely related. These two may be considered as having a common origin from a unicellular form, or the former may be derived from the latter. *Microspora*, in its chromatophore structure at least, shows some affinity with *Rhizoclonium* of the Cladophoraceae, although it is always distinguished from the latter by the absence of pyrenoids, and the single nucleus.

Tribonema in all probability had a different origin and is apparently more closely related to the Ophiocytiaceae than to the other genera of the Ulothricaceae.

I. ULOTHRIX Kützing, Flora, **16**: 517–521. 1833

Hormiscia Aresch. Act. Reg. Soc. Sci. Upsal. III. 6^1: No. 2. p. 12. *p. p.* 1866. Not Fries, Flor. Scan. 327. 1835.

Including *Hormospora* Bréb. Ann. Sci. Nat. Bot. III. **1**: 25. 1844. (?)

Filaments consisting of a single series of uninucleate cells, all (except the rhizoid-like basal cell) capable of division and reproduction. Chromatophore a homogeneous parietal band (some-

times not completely encircling the cell), enclosing one to several pyrenoids.

Asexual reproduction by means of zoöspores, formed to the number of 1–4 in any cell; they are 4-ciliate, furnished with a red eyespot, and germinate immediately, forming a holdfast. Akinetes are also formed.

Sexual reproduction through conjugation of biciliate gametes of which 8 or more may be formed in a cell.

Inhabitants of fresh and salt water. Type, *U. tenuissima* Kütz. [Etym. οὖλος, crisped, and θρίξ, hair.]

European algologists like Hansgirg and DeToni, who have contended for the prevalence of *Hormiscia* over *Ulothrix* on the ground of priority, appear to have overlooked the real date of *Ulothrix*. It is referred to by Kützing himself in the Species Algarum as founded on *U. tenuissima* Kütz. Alg. Dec. *144*. 1836. Actually, the genus was founded three years earlier by the description of this species as the type (*i. e.*, the first in order), and the addition of well-known *Conferva* species, notably *C. zonata* Web. & Mohr. Unquestionably, then, *Ulothrix* has the claim of priority over *Hormiscia* Fries, 1835.

As a matter of fact the two genera should never have been treated as synonymous, for *Hormiscia* originally included only *Conferva penicilliformis* Roth and *C. Wormskioldii* Flor. Dan., both of which have recently been acknowledged to belong to *Urospora* Aresch. rather than to *Ulothrix*. Rabenhorst ('47) at first employed *Hormiscia* in its correct, restricted sense; but in his final work (Flora Europaea Algarum) he adopted the erroneously enlarged sense of Areschoug ('66), who had placed with *Hormiscia penicilliformis* (Roth) Fries, *Ulothrix zonata* (Web. & Mohr) Kütz., a species which never belonged in such an affinity. At the same time Areschoug had established a new genus *Urospora* on a supposed new species *U. mirabilis*. In 1874 Areschoug discovered that his *Urospora mirabilis* was identical with *Hormiscia penicilliformis* (Roth) Fries, but instead of reducing his genus *Urospora* to synonymy, as he should have done, he created the new combination *Urospora penicilliformis*.

The fact that *Hormiscia* has been recently employed in the incorrect sense inaugurated by Areschoug and continued by Rabenhorst, does not militate against the necessity of reviving it

in its original sense, viz., for the species now recognized under *Urospora*.*

Hormiscia in this sense is distinguished from the marine species of *Ulothrix* by the larger size of its filaments, the chromatophore consisting of a more or less spiral band or of a somewhat reticular parietal plate, and above all by the zoöspores which are narrowed at the posterior end into a pointed tail-like process. This genus (as *Urospora*) has been removed to the Cladophoraceae by Wille ('90), on account of the multinucleate character of the cells, and therefore does not receive detailed treatment here.

Synopsis of Species

Fresh-water species.	
Filaments 11–45 μ in diameter, pyrenoids several.	
Mature filaments 25–45 μ in diameter.	1. *U. zonata.*
Cells 15–20 μ in diameter, ½ as long.	2. *U. tenuissima.*
Cells 13–16 μ in diameter, 1–2 times as long.	3. *U. aequalis.*
Cells 11 μ in diameter, ¼–½ as long.	4. *U. oscillarina.*
Filaments 5–9 μ in diameter, one pyrenoid in a cell.	
Cells 7.5–9 μ in diameter.	5. *U. tenerrima.*
Cells 5–6 μ in diameter.	6. *U. variabilis.*
Salt or brackish-water species.	
Diameter 6–15 μ, cell-wall thin.	7. *U. implexa.*
Diameter 10–25 μ, cell-wall thickened.	8. *U. flacca.*

1. ULOTHRIX ZONATA (Web. & Mohr) Kütz. Flora, **16**: 519. 1833; Phyc. Gen. 251. *pl. 80.* 1843; Spec. Alg. 347. 1849; Tab. Phyc. **2**: *pl. 90. f. 2.* 1852. Dodel, Jahrb. wissen. Bot. **10**: 417–450. *pl. 31–38.* 1876. Wolle, F. W. Alg. 133. *pl. 117.* 1887. Chodat, Beitr. Krypt. Flor. Schweiz, $\mathbf{1}^3$: 267. *f. 183.* 1902.

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* The North American species, then, are as follows:

1. HORMISCIA PENICILLIFORMIS (Roth) Fries, Flor. Scan. 327. 1835.

Conferva penicilliformis Roth, Cat. Bot. **3**: 271. 1806.

Urospora mirabilis Aresch. Nov. Act. Reg. Sci. Upsal. III. $\mathbf{6}^1$: No. 2, p. 16. 1866.

Urospora penicilliformis Aresch. Nov. Act. Reg. Sci. Upsal. III. $\mathbf{9}^1$: No. 1, p. 4. 1874.

2. HORMISCIA WORMSKIOLDII (Fl. Dan.) Fries, *l. c.* 328.

Conferva Wormskioldii Fl. Dan. *pl. 1547.* 1816.

Urospora Wormskioldii Rosenvinge, Bot. Tidssk. **18**: 57-64. 1892.

3. HORMISCIA COLLABENS (Ag.) Rabenh. Deutsch. Krypt. Flor. 2^2: 115. 1847.

Conferva collabens Ag. Syst. Alg. 102. 1824.

Hormotrichum collabens Kütz. Phyc. German. 205. 1845.

Conferva zonata Web. & Mohr, Naturhist. Reise Schwed. 97. *pl. 1. f. 7.* 1804. Lyngb. Tent. Hyd. Dan. 136. *pl. 45.* 1819. Agardh, Syst. Alg. 90. 1824.

Conferva lucens Dillwyn, Brit. Conferv. *pl. 37.* 1805. Eng. Bot. *pl. 1635.* 1806.

Myxonema zonatum Fries, Syst. Orb. Veg. **1**: 343. 1825; Flor. Scan. 329. 1835. Rabenh. Deutsch. Krypt. Flor. **2**^{2}: 99. 1847.

Lyngbya zonata Hass. Brit. F. W. Alg. 220. *pl. 59.* 1845.

Hormiscia zonata Aresch. Act. Reg. Soc. Sci. Upsal. III. **6**^{1}: No. 2. p. 12. *pl.* 2. 1866. Rabenh. Flor. Eur. Alg. **3**: 362. 1868. Cooke, Brit. F. W. Alg. 179. *pl. 69.* 1883. De Wild, Flor. Alg. Belg. 36. *f. 12.* 1896; Flor. Buitenz. **3**: 57. *f. 7.* 1900.

The filaments form yellowish-green, fluctuating masses, .5–2 dm. in length; cells cylindrical or somewhat swollen, 11–45μ in diameter, ⅓–1½ (in young filaments 3) times as long; the cell-wall at first thin, with age growing thicker, especially in the circumferential region of the septations, so that the larger cells appear to be constricted at the joints; chromatophore forming a broad or narrower girdle, enclosing several large pyrenoids (*pl. 20. f. 1–4*).

EXSICC.: Phyc. Bor. Am. *19. A.* Fairfield, Conn., Jan. 1894. (I. Holden); Not *19. B.* (=*Microspora amoena*). Tild. Am. Alg. *7.* Minneapolis, Minn., April, 1894; *131.* (var. *valida* Näg.) Lake Superior, Minn., Jul. 1896. (A. H. Elftman).

On stones or wood, in quiet or rapid waters.

VERMONT: St. Johnsbury, April (672); North Hero, June (681); Alburg, Lake Champlain; 30 June (683).

CONNECTICUT: Derby, April (538); Thomaston, May (567).

NEW YORK: Williamsbridge, April (95, 294); Woodlawn, May (596), Bronx Park, May (373); Central Park, March (260), April (323, 525, 84), May (104, 381, 382, 386, 594), June (614, 619).

NEW JERSEY: Nordhoff, May (356).

IDAHO: Nez Perces county, 1896 (A. A. Heller).

Small forms of this species make their appearance in the drinking fountains and horse troughs of New York in early spring. At first one would be inclined to refer these forms to some smaller species, but prolonged observation of the development is suffi-

cient to convince one of their relation, as young forms, to this largest species of the genus.

In May the rocky borders of the lake in Central Park become fringed with a growth which rapidly develops into the typical *U. zonata.* We have never found this growth early in the season, and it disappears soon after the first hot days at the end of May or in June.

A number of species and varieties of European authors have not been satisfactorily distinguished as more than growth forms of *U. zonata.* Such are *U. pectinalis* Kütz., *U. inaequlis* Kütz., *U. zonata attenuata* (Kütz.) Rabenh., *U. zonata varians* (Kütz.) Rabenh., *U. zonata valida* (Näg.) Rabenh., and *U. zonata rigidula* (Kütz.) Hansg.

2. ULOTHRIX TENUISSIMA Kütz. Flora, **16**: 518. 1833; Phyc. Gen. 252. 1843*

Ulothrix tenuis Kütz. Phyc. Germ. 197. 1845; Spec. Alg. 347. 1849 (Not *U. tenuis, ibid.*, 346); Tab. Phyc. **2**: *pl. 89. f. 1.* 1852. Rabenh. Flor. Eur. Alg. **3**: 366. 1868. Cooke, Brit. F. W. Alg. 182. *pl. 70. f. 6.* 1883. Wolle, F. W. Alg. 134. *pl. 118. f. 1. 2.* 1887.

Myxonema tenuissimum Rabenh. Deutsch. Krypt. Flor. **2**^{2}: 99. 1847.

Hormiscia tenuis De Toni, Syll. Alg. **1**: 165. 1889. Hansg. Prod. Alg. Böhm. **2**: 213. 1892.

Dark green; vegetative cells always thin-walled, 15–20 μ (rarely 25 μ) in diameter in mature filaments, generally about half as long or shorter, sometimes in younger filaments as long as the diameter, cylindrical, not at all constricted at the septations; chromatophore broad; zoösporiferous filaments somewhat moniliform (*pl. 20. f. 5, 6*).

In running water in brooks and watering troughs.

NEW YORK: Central Park, April (265, 535), May (380).

NEW JERSEY: Fairview, April (297).

Numerous specimens that were at first referred to this species, have been proved, after subsequent collection in the same stations,

* Kützing abandoned this name first given to the species without any expressed reason, but probably because he felt that it was not properly descriptive of the plant after he added to the genus several species that were smaller in respect to diameter.

to be younger forms of *U. zonata*. In the two stations above quoted, however, we have never been able to find typical specimens of *U. zonata*. We feel compelled, therefore, to retain this species for the present, although the remark of Hansgirg, that it apparently belongs in the cycle of forms of *U. zonata*, may be justified by future investigation.

U. tenuissima differs from typical forms of *U. zonata*, besides being of a smaller diameter, in its deeper green color, in its generally shorter cells and in its thin cell-wall. Nevertheless, certain young forms of *U. zonata* show a most perplexing similarity to the form described above.

3. ULOTHRIX AEQUALIS Kütz. Phyc. Germ. 197. 1845; Spec. Alg. 347. 1849; Tab. Phyc. **2**: *pl. 89. f. 1.* 1852; Rabenh. Krypt. Flor. Sachs. **1**: 264. 1863. Wolle, F. W. Alg. 134. *pl. 118. f. 3–5.* 1887.

Myxonema aequale Rabenh. Deutsch. Krypt. Flor. **2**^{2}: 99. 1847.

Hormiscia aequalis Rabenh. Flor. Eur. Alg. **3**: 363. 1868.

Filaments bright green in color; cells 13–16 μ in diameter, 1–2 times as long.

In a rapidly flowing brook, attached to stones, Woodlawn, New York, May (571B).

This specimen, when collected, was strikingly different in appearance from *U. zonata*, but deteriorated speedily. When the station was revisited a few days afterward to obtain material for drawing and further study, all traces of the plant had disappeared.

A specimen distributed as *Hormiscia aequalis* Tild. Am. Alg. *132*, is *Microspora* sp.

4. ULOTHRIX OSCILLARINA Kütz. Phyc. Germ. 197. 1845; Spec. Alg. 346. 1849; Tab. Phyc. **2**: *pl. 88. f. 1.* 1852. Rabenh. Flor. Eur. Alg. **3**: 366. 1868. Wolle, F. W. Alg. 137. *pl. 118. f. 34–36.* 1887. (?)

Conferva oscillatorioides Agardh, Disp. Alg. Suec. 29. 1812; Syst. Alg. 89. 1824. (?) Not Kütz. Alg. Dec. *54*. 1833 (= *Gloeotila oscillarina* Kütz. Phyc. Gen. 245. 1843 = *Stigeoclonium setigerum* Kütz. Phyc. Germ. 198. 1845).

Ulothrix oscillatorioides Crouan, Flor. Finist. 122. 1867. (?)

Hormiscia oscillarina DeToni, Syll. Alg. **1**: 167. 1889.

Cells about 11 μ in diameter, and ¼–½ as long, or equal to the diameter in length; chromatophore a broad band.

EXSIC.: Phyc. Bor. Am. *613*, Melrose, Mass., Aug. 1890, floating in a ditch (F. S. Collins).

When we visited this station in May, 1901, with Mr. Collins, no *Ulothrix* was to be seen; possibly this is unlike most species of this genus in being a summer form.

A specimen labelled *U. oscillarina* from Wisconsin in the Wolle herbarium is *Tribonema* sp.

In regard to the name of this species, it is probable that Agardh's form ought to be used. The specimen issued as *Conferva oscillatorioides* Ag. (Desmaz. Pl. Crypt. de France, *1353*) agrees closely with Mr. Collins' plant; but as we have no means of determining with certainty the character of Agardh's plant, Kützing's name is here retained, as being the one in current use.

5. ULOTHRIX TENERRIMA (Kütz.) Kütz. Phyc. Gen. 253. *pl. 9. f. 1.* 1843; Phyc. Germ. 197. 1845; Spec. Alg. 346. 1849 (Excl. var.); Tab. Phyc. **2**: *pl. 87. f. 1.* 1852. Rabenh. Krypt. Flor. Sachs. **1**: 264. 1863; Flor. Eur. Alg. **3**: 366. 1868. Gay, Rech. sur Alg. Vert. *pl. 12. f. 119.* 1891.

Conferva tenerrima Kütz. Linnaea, **8**: 346, 347, 361. *p. p.* 1833.

Myxonema? tenerrimum Rabenh. Deutsch. Krypt. Flor. **2**[2]: 99. 1847.

Ulothrix subtilis tenerrima Kirchner, Krypt. Flor. Schles. **2**[1]: 77. 1878. Wolle, F. W. Alg. 136. *pl. 118. f. 17.* 1887.

Hormiscia subtilis tenerrima DeToni, Syll. Alg. **1**: 160. 1889.

Ulothrix tenuis Kütz. Spec. Alg. 346. 1849. (?)

Filaments forming light green silky or floccose masses often 1 dm. long; cells cylindrical, 7.5–9 μ in diameter, ⅔–1⅓ times as long; cell-wall very thin; chromatophore zonate or contracted to one side of the cell, with one pyrenoid (*pl. 21. f. 3, 4*).

On the sides of an iron fountain basin, and in a wooden watering-trough, St. Johnsbury, Vermont, September and October (645, 651).

The chromatophore in the actively vegetative state is zonate, and the appearance of a filament is then like a miniature specimen

of *U. zonata.* When kept in stagnant water the chromatophore becomes reduced to a small plate, and the filament looks very much like that of *U. variabilis.* From the latter, however, it seems always to be distinguishable by its greater diameter. It might seem at first sight that this is only a large form of *U. variabilis,* but from careful observation of the living plants the points of distinction are convincing though not easily described.

The plant did not make its appearance in the two stations where we have observed it earlier than August, and probably not until during September. The chromatophores seemed to be somewhat injured by the first frosts; whether the plant would have been killed before winter could not be determined, because of the fact that the water was drained from both basins at the approach of cold weather.

6. ULOTHRIX VARIABILIS (Kütz.) Kütz. Spec. Alg. 346. 1849; Tab. Phyc. 2: *pl. 85. f. 3.* 1852. Rabenh. Krypt. Flor. Sachs. **1**: 263. 1863; Flor. Eur. Alg. **3**: 365. 1868. Cooke, Brit. F. W. Alg. 182. *pl. 70. f. 4.* 1883. (?) Wittrock; Nordensk. Stud. och Forskning. *pl. 3. f. 27, 28.* 1883. (?)

Hormidium variabile Kütz. Phyc. Germ. 192. 1845.

Ulothrix subtilis variabilis Kirchner, Krypt. Flor. Schles. 2^1: 77. 1878. Wolle, F. W. Alg. 136. *pl. 118. f. 15, 16.* 1887. (?)

Hormiscia subtilis variabilis DeToni, Syll. Alg. **1**: 160. 1889.

Filaments forming floccose masses: cells 5–6 μ in diameter, ½–1½ times as long, often square in optical section; cell-wall very thin and delicate; chromatophore rarely covering more than half the cell-wall, sometimes taking the form of a rectangular plate, sometimes that of an angular mass contracted into one corner of the cell; the pyrenoid small but distinct (*pl. 21, f. 5–7*).

In brooks and in stagnant waters.

MASSACHUSETTS: Ipswich, May (557).

NEW YORK: East Chester, May (590).

NEW JERSEY: Undercliff, Bergen county, April (278), May (369, 427*B*, 574).

It is a matter of great difficulty, if not impossible, to obtain from the exsiccatae any valuable evidence as to the essential character of such species as *Ulothrix tenerrima*, *U. variabilis*, and *U. subtilis*; the last two we have been unable to restore from dried specimens

so as to show any particular difference between their chromatophore characters. It is also generally difficult to find authoritative points of separation in the original descriptions of such fine species.

In the description, however, of *U. variabilis*, the following phrases are used : " nucleis cellularum quadratis saepius angustis pectinatim dispositis " (Kützing, '49). " Zellinhalt aufangs genau quadratisch " (Rabenhorst, '63), and " cytioplasmate initio semper quadrato-contracto (Rabenhorst, '68). Now the chromatophore of the form identified above as this species would hardly be called square, but it is generally contracted and placed on one side of the cell. Furthermore, so far as one can judge from the illustration given by Kützing ('52), our specimens conform to his species.

We believe, therefore, that there is no question as to the correctness of the above description for *U. variabilis* and of the distinctness of this form from *U. subtilis* (= *Stichococcus subtilis* Klerck.). There is certainly no question as to the specific distinctness of the two forms above described from that which is hereinafter identified as *Stichococcus subtilis.*

Illustrations like that of Wittrock ('83) for this species and that of Wille ('85) for *U. variabilis* f. *marina*, in which the chromaophore has a homogeneous, square appearance, were undoubtedly made from material not well preserved. They show exactly the similarity of appearance which is to be found in dried specimens of small forms of *Ulothrix* and *Stichococcus.*

7. ULOTHRIX IMPLEXA (Kütz.) Kütz. Spec. Alg. 349. 1849; Tab. Phyc. **2**: *pl. 94. f.* 2. 1852. Hauck; Rabenh. Krypt. Flor. Deutschl. **2**: 440. 1885. Reinbold, Schrift. Nat. Ver. Schles.-Holst. **8**: 129. 1889. Batters, Trans. Berwick. Nat. Club, — (35). 1889. Foslie. Tromsö Mus. Aarsh. **13**: 143. 1890. Collins, Bull. Torrey Club, **18**: 336. 1891.

Hormidium implexum Kütz. Bot. Zeitung, **5**: 177. 1847.

Ulothrix Ligustica Dufour, Erb. Critt. Ital. I. *1032* (*fide* De Toni).

Bangia ? confervoides Zanard. Atti R. Ist. Ven. **6**: 249. *pl. 2.* 1847.

Ulothrix ? confervoides DeToni & Levi, L'Algarium Zanardini, 134. 1888.

Ulothrix submarina Kütz. Spec. Alg. 349. 1849; Tab. Phyc. **2**: *pl. 94. f. 3.* 1852.

Hormiscia implexa Rabenh. Flor. Eur. Alg. **3**: 364. 1868. DeToni, Syll. Alg. **1**: 168. 1889.

Ulothrix flacca Dodel-Port, Illust. Pflanz. 148. *f. 28.* 1883.

Ulothrix subflaccida Wille, Vid.-Selsk. Skrift. **1900**[6]: 27. *pl. 3. f. 90–100.* 1901. (?)

Light green, forming dense tufts or masses of interwoven and contorted filaments; cells cylindrical or slightly swollen, 6–15 μ in diameter, about as long as broad or somewhat shorter; cell-walls thin; chromatophore band often incomplete (approaching the parietal dish of *Stichococcus* in appearance), inclosing one pyrenoid (*pl. 21, f. 1, 2*).

Exsic.: Phyc. Bor. Am. *115A*, Bridgeport, Conn., May, 1893 (I. Holden); *115B*, Malden, Mass., June, 1892 (F. S. Collins).

On rocks, or less frequently on grasses, in regions more or less exposed to fresh water.

New Hampshire: Little Boar's Head, 4 May, 1902 (F. S. Collins).

Rhode Island: Mackerel Cove, Conanicut Island, 21 April, 1898 (F. S. Collins).

Connecticut: Bridgeport, May (570).

New York: Larchmont, October (520); New Rochelle, May (586).

New Jersey: Undercliff, April (275, 308).

This species seems to furnish a point of connection between the more strictly marine species, *U. flacca*, and the series of exclusively fresh water forms. Batters ('89) states that *U. implexa* grows on rocks near high-water mark exposed to the drip of fresh water. We have always found it well covered with water, fresh or salt. At Bridgeport it grows near the mouth of tidal creeks where the water is nearly as salt as in the sound. At New Rochelle it seems to grow mostly below the tidal line, but at the mouth of a stream of such force that the salt water influence would be largely modified. In the other two stations it was growing near the mouth of streams exposed to salt water only during the flow of the tide.

U. implexa was reported from Florida by Wolle, Bull. Torrey Club, 6: 287. 1879.

The species seems to be less abundant than *U. flacca*, but it is probable that in some cases it has been confused with the latter or with fresh water forms.

Professor Wille ('**01**) has apparently described under the new name *U. subflaccida* the form which has long been identified as *U. implexa*. His reasons for rejecting, or at least holding in abeyance, Kützing's name (chiefly on the ground that it cannot be determined from literature just what Kützing's species was) seem to be insufficient. Many current names cannot be vouched for with absolute certainty, but until their modern application is proved to be incorrect it is less confusing to retain them. One point emphasized by Professor Wille is that the habitat of *U. implexa* as given in the Tabulae Phycologicae is "in Gräben"; but he seems to have overlooked the original description (Bot. Zeitung, 1847) where it is stated that the species is found "in submarinis, inter *Rhizoclonium interruptum*,"—exactly the sort of habitat where we find our *U. implexa*. The illustration in Tabulae Phycologicae is not bad for our species, when it is remembered that it was made (probably) from dried material.

8. ULOTHRIX FLACCA (Dillw.) Thuret; Le Jolis, Mem. Soc. Imp. Sci. Nat. Cherb. **10**: — (56). 1864. Farlow, Mar. Alg. 45. 1881. Reinbold, Schrift. Nat. Ver. Schles.-Holst. **8**: 129. 1889. Foslie, Tromsö Mus. Aarsh. **13**: 144. *pl. 3. f. 1–3.* 1890.

Conferva flacca Dillwyn, Brit. Conferv. *pl. 49.* 1805. Eng. Bot. *pl. 1943.* 1808. Lyngb. Tent. Hyd. Dan. 144. *pl. 49 A.* 1819. Aresch. Phyc. Scand. Mar. 205. 1850.

Lyngbya Carmichaelii Harv.; Hook. Brit. Flor. **2**^{1}: 371. 1833; Phyc. Brit. **4**: *pl. 186 A.* 1851.

Hormidium flaccum Kütz. Phyc. Gen. 244. 1843.

Hormotrichum flaccum Kütz. Spec. Alg. 381. 1849; Tab. Phyc. **3**: *pl. 63.* 1853.

Lyngbya flacca Harv. Phyc. Brit. **1**: xxxviii; **4**: *pl. 300.* 1851.

Hormiscia flacca Aresch. Alg. Scand. *342.*

Urospora penicilliformis Aresch. Act. Reg. Soc. Sci. Upsal. III. **9**^{1}: No. 1. p. 4. *p. p.* 1874. DeToni, Syll. Alg. **1**: 232. 1889.

Bright green, growing in short tufts or long tangled skeins; cells cylindrical with strongly thickened outer wall, 10–25 μ in diameter, ¼–¾ as long, the septations thin; chlorophyll-band filling the length of the cell, containing (in the vegetative condition) one distinct pyrenoid; when the cell contents are preparing for formation of zoöspores, many pyrenoids may be seen in a cell (*pl. 20, f. 7–9*).

Exsic.: Phyc. Bor. Am. *17*, Nahant, Mass., March, 1891. (W. A. Setchell). Alg. Exsic. Am. Bor. Mystic River, Malden, Mass. (F. S. Collins). Hauck & Richt, Phyk. Univ. *729*. Mystic River, Mass., March, 1889 (F. S. Collins).

On *Fucus* and on leaves and culms of *Spartina*, etc. (rarely on rocks), between tide limits. Common on the New England coast and in New Jersey, at least as far south as Atlantic City.

Maine: Seguin Island, Aug. 30, 1900 (M. A. Howe, *238*).

Connecticut: Bridgeport, May (571).

New York: Pelham Bay, April (12), April 18, 1901 (M. A. Howe); College Point, February (250, 251); Rosebank, Staten Island, December (231, 240); Livingston, April (326).

New Jersey: Undercliff, Bergen county, April (310, 533); Atlantic City, Dec. 25, 1888 (I. Martindale).

This species is very generally found growing on *Fucus;* on only one occasion have we seen it on rocks and shells. In this respect it is opposed to *Hormiscia penicilliformis* (*Urospora*) which is always found on rocks and timber, and never, so far as is known to us, on *Fucus* or grasses. Professor Wille ('01) states that at Dröbak *U. flacca* is found only on stones and rocks. He has created a new species, *U. pseudoflacca*, which seems to be distinguished from this only by such slight physiological or reproductive characteristics that we fail to see how he can determine which is the original *U. flacca*. Physiological characters are sometimes of importance, but it is questionable whether consistency would not demand the abandonment of the name *U. flacca* quite as much as that of *U. implexa*.

Like most fresh water forms, this species usually disappears during the summer, but it probably forms a more luxuriant growth in late autumn and winter, while the fresh water forms do not develop extensively except in spring.

DOUBTFUL SPECIES

ULOTHRIX MONILIFORMIS Kütz. Spec. Alg. 347. 1849; Tab. phyc. **2**: *pl. 88. f. 4.* 1852.

Hormidium moniliforme Kütz. Phyc. Gen. 244. 1843.

Hormiscia moniliformis Rabenh. Flor. Eur. Alg. **3**: 361. 1868. Cooke, Brit. F. W. Alg. 179. *pl. 70. f. 1.* 1883.

Light green, more or less crisped, torulose, 11–14 μ in diameter; cell-wall thickened.

EXSIC: Phyc. Bor. Am. *612.* East Haven, Conn., April, 1894 (W. A. Setchell).

This specimen is certainly a form of *Ulothrix* and corresponds exactly to Kützing's figure and description. Whether it is a distinct species, or only a condition of some other species with a thickened cell-wall, cannot at present be determined.

Wolle records this species as collected by Austin in sphagnum swamps in New Jersey (Bull. Torrey Club, **6**: 188. 1877), but the specimen in the Wolle herbarium is composed of *Microspora floccosa* in the akinete stage. The same may be said of *Ulothrix lacustris* Hilse; Rabenh. Alg. Eur. *1540,* which is quoted as a synonym of *U. moniliformis* in Rabenh. Flor. Eur. Alg. **3**: 361. 1868. Probably Wolle finally recognized the true character of his specimens, for no mention is made of the species in the Fresh Water Algae.

ULOTHRIX SUBTILIS THERMARUM Rabenh. Flor. Eur. Alg. **3**: 365. 1868. Hansg. Prod. Alg. Böhm. **1**: 59. 1886. Wolle, F. W. Alg. 136. *pl. 118. f. 18, 19.* 1887. DeToni, Syll. Alg. **1**: 160. 1889.

EXSIC.: Rabenh. Alg. Eur. *2568,* June, 1877. Bethlehem, Pa. (F. Wolle). Wittr. & Nordst. Alg. Exsic. *419.* Bethlehem, Pa. (F. Wolle).

ULOTHRIX FLACCIDA CALDARIA (Kütz.) Hansg. Prod. Alg. Böhm. **1**: 61. 1886.

Gloeotila caldaria Kütz. Phyc. Germ. 191. 1845; Spec. Alg. 363. 1849; Tab. Phyc. **3**: *pl. 32. f. 3.* 1853. Rabenh. Flor. Eur. Alg. **3**: 320. 1868.

Hormiscia flaccida caldaria Hansg. Flora, **71**: 265. 1888. DeToni, Syll. Alg. **1**: 162. 1889. Tilden, Bot. Gaz. **25**: 91. *pl. 8. f. 4, 5.* 1898.

EXSIC.: Tild. Am. Alg. *130*. Yellowstone Park, 1896.

These two varieties are forms of similar character, both growing in warm water, and it is very probable that they should be united into one species.

The diameter of *Ulothrix thermarum* is 5–6 μ, with cells 1–3 times as long. *Gloeotila caldaria* has a diameter of 5 μ (Kützing) (5.6–7.5 μ, Rabenh.) with cells 2–3 times as long.

Without study of fresh material it is impossible to say whether these forms belong to *Ulothrix* or to *Stichococcus*.

II. STICHOCOCCUS Nägeli, Neue Denkschr. Allgem. Schweiz. Gesell. **10**^{7}: 76, 77. 1849. Gay, Rech. sur Alg. Vert. 77–79. 1891.

Ulothrix (*Hormidium*) Kütz. Spec. Alg. 349. *p. p.* 1849. Not *Hormidium* Kütz. Phyc. gener. 244. 1843.

Hormococcus Chodat, Beitr. Krypt. Flor. Schweiz, **1**^{3}: 268–270. 1902.*

Filaments without a special basal cell, fine, consisting of few cells or long and *Ulothrix*-like; chromatophore a parietal curved disk or plate, usually covering not more than half of the cell-wall, containing one pyrenoid, the nucleus usually on the opposite side of the cell.

Vegetative reproduction by dissociation of the filament into single cells. Asexual reproduction through bi-ciliate zoöspores without eyespot, which are formed singly in any cell, escape through a small round hole in the cell-wall, and germinate without formation of a holdfast.

Inhabitants of damp earth, or rock, or fresh water, one species in brackish or salt water. Type *S. bacillaris* Näg. [Etym. στίχος, row, series, and κόκκος, berry.]

The genus *Hormidium* as first named by Kützing in Linnaea, **17**: 89. 1843, contained three species, *H. moniliforme*, *H. velutinum*, *H. flaccum* (Dillw.), of which the first two were *nomina nuda*. His *Phycologia generalis*, published later in the same year, in-

* The action of Chodat in proposing this new name is inexplicable. All the species included in it are placed by recent authors in *Stichococcus*, and the two genera are therefore exactly synonymous except that for the type of this new genus the species *Stichococcus flaccidus* has been selected instead of *S. bacillaris*. Equally unjustifiable in the light of recent investigation is the inclusion of the well-marked species *S. flaccidus*, *S. dissectus*, *S. bacillaris* and *S. fragilis* to say nothing of *Hormidium nitens*, as varietal forms under the single Sammelspecies *Hormococcus flaccidus*.

cluded in the genus the same species in the same order, with descriptions. In his final work, *Species Algarum* (1849), Kützing placed *H. moniliforme* in its present position in *Ulothrix*, *H. flaccum* in the genus *Hormotrichum*, and for *H. velutinum*, together with additional forms created the section *Hormidium* under *Ulothrix*. Of the three original species, the first and third are now recognized as belonging in *Ulothrix*, while *H. velutinum* is referred to *Schizogonium*. Clearly, then, Gay, ('91) was justified in abandoning the name *Hormidium*.

There are, however, several species among those referred to *Hormiscia* (*Ulothrix*) by DeToni ('89) which form, together with certain more recently described species, a group possessing characters which furnish good reason for their separation from *Ulothrix*. These were placed by Gay in the genus *Stichococcus* Nägeli ('49) because of their tendency, in common with *S. bacillaris*, toward aërial life and vegetative reproduction. Because of the supposed absence of reproduction by zoöspores this genus was placed with the Protococcaceae rather than with the Ulothricaceae. Klercker ('96) went a step farther, and added to *Stichoccocus* a form which he supposed to be *Ulothrix subtilis* Kütz., a species which is very generally aquatic.

Now in one of the best known *Stichococcus* species, *S. flaccidus* (Kütz.) Gay, Klebs ('96) found zoöspores (there seems to be no reason for doubting the correctness of the determination of the species). He therefore revived the genus *Hormidium*, because of his objection to the name *Stichococcus* as implying affinities with the Protococacaeae. Our own investigations have shown convincingly that all the forms belonging to this group that are known in America, with one possible exception, at times reproduce by zoöspore formation, hence there is not the slightest doubt that the genus must be kept in the closest affinity with *Ulothrix*.

The single species in which we have not observed zoöspores is *Stichococcus bacillaris* Nägeli, the historical type of the genus. Nevertheless, as we cannot say that zoöspores are never formed in this species, which has every appearance of close affinity with the rest, and there is no other name available, it is necessary to retain these forms under the name by which they are known in recent literature.

Synopsis of Species

Cells cylindrical, hardly constricted at the dissepiments.
- Cell diameter 2.5–3 μ, 1–4 times as long, filaments short. 1. *S. bacillaris.*
- Cell diameter 3–3.5 μ, 1–10 times as long, filaments elongated. 2. *S. scopulinus.*
- Cell diameter 5–6 μ, 1–2 times as long; marine form. 3. *S. marinus.*
- Cell diameter 5–6.5 μ, 1–3 times as long, filaments elongated. 4. *S. subtilis.*

Cells constricted at the dissepiments, or somewhat tumid.
- Cell diameter 6–9.5 μ, on damp rocks, earth, etc. 5. *S. flaccidus.*
- Cell diameter 6.5–9 μ, in cascades. 6. *S. fluitans.*
- Cell diameter 8–11 μ, forming holdfasts. 7. *S. rivularis.*

1. STICHOCOCCUS BACILLARIS Nägeli, Neue Denkschr. Allgem. Schweiz. Gesell. **10**[7]: 77. *pl. 4 G. f. 1.* 1849. Rabenh. Flor. Eur. Alg. **3**: 47. *f. 21.* 1868. Hansg. Prod. Alg. Böhm. **1**: 139, *f. 85.* 1886; Phyc. u. Alg. Stud. *pl. 4. f. 5.* 1887. DeToni & Levi, Notarisia, **2**: 281–283. 1887; Flor. Alg. Ven. **3**: 125. 1888. DeToni, Syll. Alg. **1**: 687. 1889. Gay, Rech. Sur Alg. Vert. 78. *pl. 11. f. 107.* 1891. Klercker, Flora, **82**: 102. *pl. 6. f. 9–13.* 1896.

Protococcus bacillaris Näg.; Kütz. Spec. Alg. 198. 1849.

Hormococcus flaccidus bacillaris Chodat, Beitr. Krypt. Flor. Schweiz, **1**[3]: 269. 1902.

Filaments pale green, fine and short (composed of 2–24 cells, DeToni), very readily breaking apart; cells cylindrical but slightly constricted at the ends, 2.5–3 μ in diameter, 1–4 times as long; chromatophore thin and pale, elliptical (*pl. 22. f. 1*).

On damp earth or rock, and on flower pots, etc., in greenhouses, Central Park, New York, June (637).

Ib. S. BACILLARIS Näg. forma **confervoidea** f. nov.

Filaments longer, often crisped, usually growing in association with masses of *Tribonema* and other confervae; cell characters as in the typical form (*pl. 22. f. 2, 3*).

Filaments scattered or in small floccose masses, in pools or gently flowing water.

MASSACHUSETTS: Pine Banks Park, Melrose, April (550).

NEW YORK: Botanical Garden, April (534B); Central Park, May.

NEW JERSEY: Ridgefield, April (298).

So far as can be seen this form differs from the type only in the length of the filaments and in its habitat. Neither this nor the typical form has been studied sufficiently to make it possible abso-

lutely to connect the two in life history; but as there is every reason to believe that this is only a form which has been favored by a more abundant supply of water, we feel obliged to make this disposition of it. As it is a generally distributed, though not abundant form, one may better call attention to it than ignore it.

2. **Stichococcus scopulinus** sp. nov.

Filaments forming long, bright green, lubricous masses; cells cylindrical, not constricted at the dissepiments, 3–3.5 μ in diameter, 1–10 times as long: cell-wall very thin: chromatophore narrow, pale green, without a distinct pyrenoid: asexual reproduction, by means of a single zoöspore formed in each cell, more frequent than the vegetative mode (*pl. 22, f. 4–6*).

Hanging in skeins from dripping rocks, Morningside Park, New York, April (263, 321A, 285, 353 *p. p.*, 531).

This species is distinguished from *Stichococcus bacillaris* f. *confervioidea* usually by longer cells, and by its manner of growth in long dense masses of straight filaments instead of in scattered, crisped filaments or small floccose masses, as in that form.

It is usually abundant at the type station during the winter and early spring. Later it gives way to *S. subtilis*, but careful and repeated observations have furnished convincing evidence that it is not a young stage of that plant, but a distinct species.

Stichococcus scopulinus does not long persist in the filamentous state when brought into the laboratory; very soon it either breaks up into the coccoid state or forms zoöspores abundantly.

3. **Stichococcus marinus** (Wille)

Ulothrix variabilis Kütz. (?) forma *marina* Wille, Dijmphna-Togtets Zoöl.-bot. Udbytte, 87. *pl. 13. f. 8.* 1885. (?)

Filaments dark green; cells cylindrical, 5–6 μ in diameter, 1–2 times as long; chromatophore a roundish or oblong plate, pyrenoid indistinct.

One zoöspore is formed in a cell and escapes through a small round aperture (*pl. 21, f. 8, 9*).

EXSIC.: Phyc. Bor. Am. *615*. Ash Creek, Bridgeport, Conn., August, 1895 (I. Holden), incorrectly quoted as *U. variabilis* Kütz. var. *marina* Wille, Rhodora, **2**: 12. 1900.

In tangled masses about culms of *Spartina*, in company with *Ulothrix implexa;* bank of Yellow Mill Pond, Bridgeport, Conn.,

18 May, 1901 (570B). Mt. Desert, Maine, July 17, 1900 (F. S. Collins).

The figure accompanying Professor Wille's original description of this form leads us to doubt whether our American specimens should be identified with it. There is no question, however, that both of the Connecticut specimens are the same species and also no question, in our judgment, that they should be referred to *Stichococcus* rather than to *Ulothrix*.

Professor Wille's identification of the specimen issued in the Phycotheca was not based, of course, upon living material, a condition which is essential to a critical treatment of such fine species. Under the kind direction of Mr. Holden, we made a careful attempt to duplicate the specimen from the same station, but in vain. In a tidal creek of the same harbor, however, where the conditions were exactly similar, we obtained material which was undoubtedly of the same species as that collected by Mr. Holden.

From a careful study of this fresh material in comparison with exsiccatae, the species proves to be more closely allied to *Stichococcus subtilis* than to *Ulothrix variabilis*. The cells are frequently longer than in the latter species, the chromatophore is more like that of *S. subtilis* and lacks the clearly refractive pyrenoid characteristic of *Ulothrix*. The appearance of the chlorophyll was decidedly different from that of *U. implexa* with which this species was associated, and showed the bluer tint which is more characteristic of many *Stichococcus* species. The fact that only one zoöspore was formed in a cell, while not conclusive proof, points to *Stichococcus* rather than *Ulothrix*, for filaments of *U. implexa* possessing only a slightly larger diameter contained several zoöspores in a cell. On the whole, therefore, we are convinced that the species belongs in *Stichococcus*.

4. STICHOCOCCUS SUBTILIS (Kütz.) Klercker, Flora, **82**: 103. 1896

Ulothrix subtilis Kütz. Phyc. Germ. 197. 1845; Spec. Alg. 345. 1849; Tab. Phyc. **2**: *pl. 85. f. 1.* 1852. Rabenh. Flor. Eur. Alg. **3**: 365. 1868. Kirchn. Krypt. Flor. Schles. **2**^{1}: *77. p. p.* 1878. Wille, F. W. Alg. 135. *pl. 118. f. 9, 10 p. p.* 1887. Chodat, Beitr. Krypt. Flor. Schweiz, **1**^{3}: 268. 1902.

Hormiscia subtilis DeToni Syll. Alg. **1**: 159. *p. p.* 1889.

Filaments long, often forming extended bright green, lubricous masses; cells cylindrical, not constricted at the dissepiments, 5–6.5 μ (rarely 8 μ) in diameter, 1–3 times as long; cell-wall thin; chromatophore elliptical, containing a rather small pyrenoid. Zoöspores are formed freely at certain times; the cells break apart for vegetative propagation less readily than in any other species (*pl. 21, f. 10–13*).

EXSIC.: Phyc. Bor. Am. (*Ulothrix subtilis*), *614A.* Medford, Mass., June, 1892; *614B.* Melrose, Mass., August, 1898 (F. S. Collins); *614C.* Nantucket, August, 1895 (W. A. Setchell).

On moist or dripping cliffs, on rocks of cascades, in watering-troughs and in quiet waters.

VERMONT: St. Johnsbury, August to October (642, 647).

MASSACHUSETTS: Melrose, April (549).

CONNECTICUT: Thomaston, September (494), May (543); Plymouth, October to May (665, 521, 523); Watertown, May (561, 562).

NEW YORK: Botanical Garden, April (534B); Morningside Park, April (264, 285B, 321B, 353), May (425), June (616), November (512); Central Park, June (617, 637A).

NEW JERSEY: Long Branch, September (477); Undercliff, Bergen county, December (232), April, May (528C, 368, 427A, 576).

PENNSYLVANIA: Bethlehem, June (444).

The filaments of this species show a greater stability than those of any other, with the possible exception of *S. rivularis.* Only rarely are zoöspores seen; sometimes in warm weather they are developed rather freely. The plant is capable of enduring the greatest extremes of dryness or immersion; it vegetates on rocks until their faces become quite dried up in the summer, and, on the other hand, it presents a luxuriant growth amid the icy waters of a watering-trough or in a frozen cascade in winter. Several filaments from drying rock appeared to be forming akinetes in preparation for the summer, but where the water supply is favorable, probably the plant continues to grow during the whole year.

This species perhaps is the one most nearly related to *Ulothrix,* yet its chromatophore and pyrenoid, in the state of active growth, always have the typical *Stichococcus* character. Further-

more, physiologically it behaves like other species of *Stichococcus*, in that its cell-walls do not become gelatinous like those of *Ulothrix* when kept in stagnant cultures. In describing the species under this genus, Klercker identified it with hesitation with Kützing's *Ulothrix subtilis*, but in our judgment the figure furnished by Kützing makes the identification as certain as in the case of most of our species of that date.

Of the eight or more varietal forms that have accumulated about *Ulothrix subtilis* from the time of Rabenhorst down to Hansgirg, at least three (viz., *variabilis*, *stagnorum* and *tenerrima*) belong to other genera than *Stichococcus*; it is doubtful whether some of the rest can be placed in close relation with this species as here interpreted, even if they are to be brought into the genus.

The form illustrated by Kützing (Tab. Phyc. **2**: 31. *pl.* 97. *f.* 4. 1852) under the name *Ulothrix rupicola* Bailey, but apparently never described, appears both from the figure and from an authentic specimen furnished by Mr. Collins, to be simply *Stichococcus subtilis*.

5. STICHOCOCCUS FLACCIDUS (Kütz.) Gay, Rech. sur Alg. Vert. 79. *pl.* 11. *f.* 101–106. 1891. Klercker, Flora, **82**: 104. 1896. De Wild. Flor. Alg. Belg. 94. *f.* 42. 1896.

Ulothrix flaccida Kütz. Spec. Alg. 349. 1849; Tab. Phyc. **2**: *pl.* 95. *f.* 2. 1852. Rabenh. Flor. Eur. Alg. **3**: 367. 1868. Wolle, F. W. Alg. 137. *pl.* 118. *f.* 27, 28. 1887. De Wild. Bull. Soc. Bot. Belg. **27**^{2}: 79–81. 1888.

Hormidium flaccidum Braun; Rabenh. Alg. Eur. *2480.* 1876. Klebs, Fortpflanz. Einig. Alg. 341–345. *pl.* 2. *f.* 21–24. 1896.

Hormiscia flaccida Lagerh. Flora, **71**: 62. 1888. Hansg. Flora, **71**: 265. *p. p.* 1888. DeToni, Syll. Alg. **1**: 161. *p. p.* 1889.

Hormococcus flaccidus a flaccida [*sic*] Chodat, Beitr. Krypt. Flor. Schweiz, **1**^{3}: 269. 1902.

Filaments rather short, forming floccose masses or interwoven strata: cells generally somewhat tumid, 6–9.5 μ (6–14 μ, Gay) in diameter, ¼–2 times as long: cell-wall thicker than in *S. subtilis*; chromatophore broad, containing a large pyrenoid.

Reproduction by zoöspores, as well as by the vegetative mode, frequent (*pl.* 21, *f.* 14–17).

EXSIC: Phyc. Bor. Am. *116*. Cambridge, Mass., Jan., 1890 (W. C. Sturgis).

On wet rocks and on moist bark of trees. Probably widely distributed.

MASSACHUSETTS: Reading, Aug. 28, 1898 (F. S. Collins).

NEW YORK: Central Park, April to June (315, 536, 618); Greenhouse, Botanical Garden, June.

This form at times resembles *S. subtilis*, but is generally distinguishable from that species by its shorter, tumid cells with the thicker cell-wall; it is also less aquatic in its tendencies.

We have been unable to find this species on trees, but Mr. Collin's specimen shows a luxuriant growth on willow bark.

Most recent writers have included in the synonymy of this species, or at most have considered as a variety of it, *Ulothrix nitens* Menegh.; Kütz. Spec. Alg. 349. 1849. Klebs ('98), however, has maintained the specific distinctness of the form as *Hormidium nitens* Menegh. in spite of the fact that morphologically it is hardly separable from *S. flaccidus*. We have seen no living specimens that could be referred to this form, and cannot, therefore, express an opinion of any weight regarding the characters, chiefly physiological, upon which Klebs grounds its specific distinctness.

The American exsiccatae, *Ulothrix* (*Hormidium*) *nitens* Rabenh. Alg. Eur. *2515*, collected by Wolle at Bethlehem, Pa., and *Hormiscia flaccida nitens*, Tilden, Am. Alg. *6*, from Minnesota, are hardly distinguishable from *S. subtilis*. The figure given by Saunders (Flora of Nebraska, *pl. 22. f. 2.* 1894) certainly has nothing to do with *Stichococcus*; it appears to be a form of *Mougeotia*.

6. STICHOCOCCUS FLUITANS Gay, Bull. Soc. Bot. France **40**: CLXXIV. *f. 1.* 1893. Klercker, Flora, **82**: 103. 1896.

Filaments yellowish-green, often much crisped and densely interwoven, torulose, sometimes geniculate, very readily breaking up into single cells; cells slightly constricted at the dissepiments, 6.5–9 μ in diameter, 1–3 times as long; chromatophore large and opaque, obscuring somewhat the dull pyrenoid. Reproduction by zoöspores infrequent (*pl. 22, f. 7–9*).

EXSIC.: Phyc. Bor. Am. *759*. Melrose, Mass., May 1, 1900 (F. S. Collins).

In cascades on oblique surfaces of rocks dashed with spray or covered by a thin sheet of water. Melrose, Mass., 28 April, 1901 (548). Undercliff, New Jersey, 9 April, 16 April, 1900 (279, 307), 20 May, 1901 (575).

The conditions in these two stations are exactly similar. On certain rocks, the plants form a cespitose covering presenting the appearance of a short *Myxonema*. By this habit and by its yellowish green color, this species is always distinguishable to the naked eye, from the long, darker green skeins of *Stichococcus subtilis*, which frequently hang from adjacent rocks. The specimens from both stations showed, in the most marked degree, the tendency to dissociation of the filaments. Within a few hours after being removed from the rapid current on the rock, a very large proportion of the filaments had broken up into single cells or chains of two to four.

Our American specimens show a distinct, though not strongly marked torulose character of the filaments, which is not mentioned by Gay, while the geniculate character emphasized by him does not appear prominent. However, as the identification of Mr. Collins' specimen was made by Professor Wille, we do not feel justified in making a different disposition of the plant without further evidence from the author of this species, and this we have been unable to obtain.

7. **Stichococcus rivularis** (Kütz.)

Hormidium rivulare Kütz. Phyc. German. 192. 1845.

Ulothrix rivularis Kütz. Spec. Alg. 346. 1849; Tab. Phyc. **2**: *pl. 86, f. 2.* 1851; not Alg. Dec. *49.* 1833 (= *Rhizoclonium*). Rabenh. Flor. Eur. Alg. **3**: 366. 1868. Wolle, F. W. Alg. 136. *pl. 118. f. 6–8.* 1887.

Ulothrix rivularis var. *cataracta* Wolle, *ibid. pl. 118. f. 29–33.*

Hormiscia rivularis DeToni, Syll. Alg. **1**: 167. 1889.

Filaments forming somewhat elongated bright green tufts, frequently geniculate, but not easily breaking apart, composed of 1–3 cells, developing rhizoidal hooks from the terminal cells and from those of the knees; cells somewhat constricted at the dissepiments, rather thick-walled, 8–11 μ in diameter, 1–2 times as long; chromatophore orbicular to elliptical or rhomboidal, with clear-cut outline, containing a large pyrenoid (*pl. 22, f. 10–13*).

On rock or earth in rapids of grassy meadow streams.

Thomaston, Conn., May (568).

This species has a superficial resemblance to *S. fluitans*, but differs from it in the strong tendency of the filaments to stability, and in the much clearer green and clean-cut character of the chromatophores, with their more distinct pyrenoid. The geniculations in this species have a much more permanent character than those of *S. fluitans*; there they appear to arise simply from the excessive tendency to dissociation of the cells, while here they arise from the irritation of cells as they are pressed upon the substratum by the current. The rhizoidal structures are here very different from the basal cells in *Ulothrix*, their cell-walls are thickened only in a slight degree, and the chromatophore retains nearly its normal character; there is every evidence that here they are always developed secondarily as tendril-like organs, and not at the germination of the zoöspore as in *Ulothrix*. Zoöspores were not formed freely in our specimens, though some cells from which they had emerged were found.

There appears to be no sufficient *raison d'être* for Wolle's var. *cataracta* since the characters on which it is founded are mentioned in Kützing's descriptions of the species.

III. MICROSPORA Thuret, Ann. Sci. Nat. Bot. III. **14**: 221. 1850. Lagerh. Ber. Deutsch. Bot. Gesell. **5**: 413–417. 1887. Flora, **72**: 207–209. 1889. Not *Microspora* Hassall, Ann. & Mag. Nat. Hist. **11**: 363. May, 1843 (= *Cladophora* Kütz. Linnaea, **17**: 91. 1843).*

Filaments simple, generally unattached and with little difference between base and apex. Chromatophore a granular band or sheet covering more or less completely the outer cell-wall and the dissepiments, sometimes perforate or reticular, without pyrenoids

* Hassall's genus *Microspora* had for its type *Conferva glomerata* L. and would supplant Kützing's *Cladophora* if it should be proved that Hassall's work was published earlier in the year 1843 than Kützing's. Probably, however, Kützing's work in the first Heft of Linnaea appeared earlier than May, the published date of Hassall's paper. Hassall ('45) himself abandoned his *Microspora* in favor of Kützing's *Cladophora*. Since, therefore, *Microspora* Hassall is never likely to be taken up again, it has been thought best to waive a too strict application of the article of the Rochester Code in regard to homonyms and to retain the only *Microspora* that has ever been in general use.

but containing scattered granules of starch. Cell-wall composed of layers of cellulose which, for the dispersal of zoöspores, pull apart in such a way as to leave sections which appear like a letter H in optical section.

Asexual reproduction by means of 2- or 4-ciliate zoöspores, one or two in each cell; also by means of 2-ciliate microzoöspores, several formed in a cell (gametes?); germination of both kinds direct. Akinetes and aplanospores are also produced.

Inhabitants of fresh water. Type *M. floccosa* (Vauch.) Thuret. [Etym. μικρός, small, and σπορά, spore.]

Thuret separated this genus from *Conferva* on account of the squared appearance of the chromatophore and the method of dispersal of the zoöspores, namely, by the pulling apart of the halves of the cell-wall.

Both genera were recognized by Rabenhorst ('63, '68) and by Wolle in his earlier study, as is evidenced by his published lists and by labels in his herbarium. Wille ('81), taking no account of chromatophore form, but making an elaborate study of exsiccatae, reunited *Microspora* with *Conferva* because he found that in certain species left in *Conferva* (*Tribonema*) the structure of the cell-wall is similar to that described for *Microspora*. It remained for Lagerheim ('87, '89) to define properly both genera by their chromatophore characters and assimilation products.

A great effort has been made to furnish a contribution to the meager knowledge of the reproductive processes in this genus, but it is a matter of great difficulty to obtain zoöspores in any species. We have seen them produced only in two cases, in *Microspora floccosa* and *M. stagnorum*. In the case of the former, only a single filament was forming zoöspores, and the number of cilia could not be made out, though the specimen was immediately fixed in osmic vapor. In *M. stagnorum* the zoöspores, which did not seem at all like gametes, had only two cilia, whereas they are usually said to be 4-ciliate.

Akinetes are frequently seen in most of the species. The filaments become moniliform, the cell-wall thickens and finally the cells fall apart as globose bodies, which, in the mass, resemble resting cells of *Chlamydomonas*. It is probable that these akinetes usually go through a period of rest before germinating.

Synopsis of Species

Filaments large, cell-walls 1.5–3 μ thick.
- Cells nearly cylindrical, diameter 28–33 μ, 1–1.6 times as long. 1. *M. crassior.*
- Cells nearly cylindrical, diameter 21.5–25 μ, 1–2 times as long. 2. *M. amoena.*
- Cells somewhat tumid, diameter 16.5–20 μ, 1–2 times as long. 3. *M. Loefgrenii.*
- Cells perfectly cylindrical, diameter 19.5–20 μ, 1–2½ times as long. 4. *M. Wittrockii.*

Filaments smaller, cell-walls thin.
- Cells cylindrical, diameter 14–17 μ. 5. *M. floccosa.*
- Cells cylindrical, diameter 11–14 μ. 6. *M. Willeana.*
- Cells cylindrical, diameter 7.5–9.5 μ. 7. *M. stagnorum.*
- Cells slightly constricted, diameter 6.7–9.5 μ. 8. *M. tumidula.*
- Cells cylindrical, diameter 5.5–7 μ. 9. *M. quadrata.*

1. Microspora crassior (Hansg.)

M. amoena crassior Hansg. Sitz.-ber. K. Böhm. Gesell. Wiss. **1889**[1]: 129. 1889; Prod. Alg. Böhm. **2**: 223. 1893. Schmidle, Ber. Deutsch. Bot. Gesell. **11**: 544. 1893.

M. amoena crassa Schmidle, Ber. Nat. Gesell. Freib. **7**: 75. *pl. 2. f. 1.* 1893.

M. amoena forma *crassior* Wille, Rhodora, **1**: 149. 1899.*

Filaments long and dark green: cells nearly cylindrical, 28–33 μ in diameter, 1–1.6 times as long; cell-wall 2.5–3 μ thick, the lamellate structure often distinct; chromatophore dense, usually covering the whole cell-wall and obscuring the large nucleus (*pl. 23, f. 2*).

EXSIC.: Phyc. Bor. Am. *616 p.p.* Bridgeport, Conn., April, 1893 (I. Holden). (?)

Growing in thick, tangled masses in rapid water, or as scattered filaments with *M. amoena* or *M. Loefgrenii.*

NEW YORK: Larchmont, May (588); Van Cortlandt Park, June (632); Central Park, June (620), September (490), October (659).

This species is distinguished from *M. amoena*, chiefly by its

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*Schmidle (1900) quotes as an additional synonym *Microspora DeToniana* Lagerh. Nuova Notarisia, **4**: 137. 1893, and states that of the three names proposed by himself, Hansgirg, and DeToni in the year 1893 it is difficult to decide which has priority. He has overlooked the fact that Hansgirg's variety was actually established in 1889. Schmidle also thinks it probable that *Conferva Raciborskii* Gutwinski (Flora Glon. Galicyi 7. *pl. 3. f. 1.* 1892; Nuova Notarisia, **3**: 17. 1892) is to be identified with this form. The correctness of such an identification appears to us to be more than doubtful; certainly the form called *C. Raciborskii* by West (Journ. Bot. **31**: 98. *pl. 333. f. 9.* 1893) differs widely from *Microspora crassior*, in its smaller diameter and much thicker cell-wall.

larger size and shorter cells. Judging from all specimens we have seen, it is more distinct from the latter than is *M. Loefgrenii.* In the Central Park station, where we have observed it at several different seasons, it shows a very constant character, and is never mixed with any other *Microspora.* There it is usually found with *Cladophora* and *Rhizoclonium*, in a stream gushing from and over rocky ledges to feed the lower lake.

In other cases, where it has been found in connection with *M. amoena* (588) and *M. Loefgrenii* (632), no intergrading forms have been seen, and there has been no evidence of any developmental relationship.

In two specimens of the exsiccata above quoted, nothing but *M. amoena* has been found, but Professor Wille's forma *crassior* is based on this material. His characterization of the form consists only of a statement of the diameter of the cells (without any reference to synonyms), but judging from this point alone the form is to be included here.

2. MICROSPORA AMOENA (Kütz.) Rabenh. Flor. Eur. Alg. **3**: 321. 1868. Lagerh. Ber. Deutsch. bot. Gesell. **5**: 417. 1887. DeToni, Syll. Alg. **1**: 227. 1889. Kirchn. Mik. Pflanz. 12. *pl. 2. f. 26.* 1891. Hansg. Prod. Alg. Böhm. **2**: 222. 1892. De Wild. Flor. Alg. Belg. 46. 1896.

Conferva amoena Kütz. Spec. Alg. 372. 1849; Tab. Phyc. **3**: *pl. 45. f. 5.* 1852. Kirchn. Krypt. Flor. Schles. **2**[1]: 79. 1878. Wille, Öfvers. Vet. Akad. Förhand. **1881**[8]: 21. *pl. 10. f. 57.* 1881. Hansg. Prod. Alg. Böhm. **1**: 77. 1886. Wolle, F. W. Alg. 140. *pl. 121. f. 1–5.* 1887.

Filaments forming long green skeins or tangled masses; cells nearly cylindrical, often slightly contracted at the dissepiments, 21.5–25 μ in diameter, 1–2 times as long; cell-wall 2.5–3 μ thick; chromatophore rather dense, generally covering the cell-wall and obscuring the nucleus which is 6.5–7.5 μ in diameter (*pl. 23, f. 1*).

EXSIC.: Phyc. Bor. Am. *616, p. p.*, Bridgeport, Conn., April, 1893 (I. Holden); *19B* (as *Ulothrix zonata*), Melrose, Mass., April, 1894 (F. S. Collins); Tild. Am. Alg. *139A* (as *M. floccosa*), Forest Grove, Oregon, Feb., 1896 (F. E. Lloyd).

In brooks, streaming in masses from sticks and stones on which it is caught.

MASSACHUSETTS: Middlesex Fells Reservation, July (447B); Worcester, 1887. G. E. Stone.

NEW YORK: East Chester, May (393, 590, 592); Larchmont, May (588); Staten Island, December (242).

NEW JERSEY: Undercliff, Bergen county, March (438), April (276), May (125, 573); Englewood, May (362).

Wolle remarks that this species is not frequent, but is abundant where it does occur. It is, however, rather common about New York, especially in rapid streams, and probably it is generally distributed.

3. MICROSPORA LOEFGRENII (Nordst.) Lagerh. Ber. Deutsch. bot. Gesell. **5**: 417. 1887; Flora, **72**: 208. 1889. DeToni, Syll. Alg. **1**: 229. 1889.

Conferva Loefgrenii Nordst.; Wittr. & Nordst. Alg. Exsic. *421*. 1882; Bot. Notiser, **1882**: 55. 1882.

Filaments long; cells slightly but distinctly ventricose, 16.5–20 μ in diameter, 1–2 times as long; cell-wall 2.5 μ thick; chromatophore dense and covering the whole cell-wall, the nucleus obscure, 5–6.5 μ in diameter (*pl. 23, f. 3, 4*).

Growing with *M. amoena*, or in long tangled skeins unmixed.

MASSACHUSETTS: Middlesex Fells, July (447A).

NEW YORK: Westchester county, April (351); Van Cortlandt Park, May, June (598, 632).

Some specimens of this species are so similar in appearance to *M. amoena* that it requires close study to separate the forms, and probably this is the reason why it has not before been reported from North America. The specimens found in Middlesex Fells growing with *M. amoena*, however, were most distinct from that species, always easily separable by the smaller diameter and moniliform tendency of the filaments; they seem to agree perfectly with the material which formed the type (Wittr. & Nordst. Alg. Exsic. *421*). Nordstedt's remark in describing this species, "Formâ cellularum ad *C. amoenam* Kütz. et *C. Wittrockii* accedens, structurâ membranae differt," seems superfluous, for in this type material, the normal *Microspora* membrane structure is clearly recognizable.

The form issued as *M. Loefgrenii* forma *minor* Wille (Phyc. Bor. Am. *617*, Middlesex Fells, Mass., May, 1899, F. S. Col-

lins) would seem, judging by the meager description, to be associable with *Conferva Loefgrenii Suecica* Wittr., but examination proves it to be very different from that variety as issued in Wittr. & Nordst. Alg. Exsic. *518*. 1883. In the character of the chromatophore and in other features, Mr. Collins' specimen seems to be more closely allied to *M. floccosa*.

4. MICROSPORA WITTROCKII (Wille) Lagerh. Ber. Deutsch. bot. Gesell. **5**: 417. 1887; Flora, **72**: 208. 1889. DeToni, Syll. Alg. **1**: 228. 1889.

Conferva Wittrockii Wille, Öfers. Vet. Akad. Förhand. **1881**[8]: 20. *pl. 9. f. 1–11.* 1881. (?); Jahrb. wiss. Bot. **18**: 461. *pl. 17. f. 35–42.* 1887.

Filaments forming long, silky skiens, light green in color; cells perfectly cylindrical, never constricted at the dissepiments, 19.5–20 μ in diameter, 1–2½ times as long; cell-wall thinner than in *M. amoena* and *M. Loefgrenii*, about 1.5 μ thick, not exhibiting its lamellated structure in the vegetative state; chromatophore thin, often perforated or sieve-like in appearance, sometimes retreating from one end of the cell so as to be thimble-shaped, the large nucleus (5–6.5 μ in diameter) nearly always clearly showing through (*pl. 23, f. 5–7*).

In a brook draining a swamp, Van Cortlandt Park, New York, April, May (287, 348, 415). Meadow brook, Norwich, Vermont, May, 1902 (675).

This form, which has not before been reported in this country, was observed and collected several times in the spring of 1900. It was always growing without other accompanying species than the small form *Microspora stagnorum*. During the spring of 1901, all search for it in the same brook was fruitless, but *M. Loefgrenii* was found in abundance, although during the preceding season the nearest station of the latter species was in another stream half a mile or more distant. This circumstance cast suspicion on the distinctness of the form determined as *M. Wittrockii*.

However, a very careful reëxamination of various collections preserved by different methods, has shown in the most convincing manner that the specimens in question are not to be confused with *M. Loefgrenii* or *M. amoena*. Our form is distinguished by its perfectly cylindrical cells, the thin walls of which do not show the lamellated structure until after maceration, and by its thin chro-

matophore, which permits a clear view of the nucleus, while in the related species, the nucleus is distinctly seen only after fixation or staining. Furthermore, this form always gave a very feeble test for starch, while the other species are generally rich in starch. Even in the field the much lighter green color was noticeable. The recent collection made in Vermont only confirms our view as to the distinctness of this species.

As to the definition of *M. Wittrockii* there is some confusion; for in Professor Wille's original description the species had a diameter of 12–20 μ, while in his German revision of the paper he increased it to read 20–24 μ. The specimen in Wittr. & Nordst. Alg. Exsic. *422*, seems to agree with the first description. The details given in the revised description, however, together with the accompanying illustrations, leave no doubt that our form is to be identified with this species.

5. MICROSPORA FLOCCOSA (Vauch.) Thuret, Ann. Sci. Nat. Bot. III. **14**: 221, 222. *pl. 17. f. 4–7.* 1850. Cooke, Brit. F. W. Alg. 136. *pl. 53. f. 3.* 1883. DeToni, Syl Alg. **1**: 226. *p. p.* 1889. De Wild. Flor. Alg. Belg. 46. 1896; Flor. Buit. 63. 1900.

Prolifera floccosa Vaucher, Journ. de Phys. **52**: *pl. 4. f. 12.* 1800; Hist. Conferv. 131. *pl. 14. f. 3.* 1803. (?)

Conferva floccosa Agardh, Disp. Alg. Suec. 29. 1812; Alg. Dec. 19. 1813; Syn. Alg. Scand. 79. 1817; Syst. Alg. 89. 1824. (?) Wolle, F. W. Alg. 140. *pl. 120. f. 21–29.* 1887.

Conferva fugacissima Lyngb. Tent. Hyd. Dan. *pl. 46. f. 1–4.* 1819. (?)

Lyngbya floccosa Hass. Brit. F. W. Alg. 223. *pl. 60. f. 1, 2.* 1845. (?)

Hormiscia floccosa Derb. & Sol. Mem. Phys. Alg. 16. *pl. 5. f. 1–8.* 1856. (?)

Not *C. floccosa* Lyngb. Tent. Hyd. Dan. 138. *pl. 46B.* 1819 (=*Stichococcus?*). Kütz. Spec. Alg. 371. 1849; Tab. Phyc. **3**: *pl. 43. f. 3.* 1852. Kirchn, Krypt. Flor. Schles. 2^1: 79. 1878. Wille, Öfvers. Vet.-Akad. Förhand. $\mathbf{1881}^8$: *pl. 10. f. 47–49.* 1881. Hansg. Prod. Alg. Böhm. **1**: 75. 1886.

Not *M. floccosa* Rabenh. Krypt. Flor. Sachs. **1**: 245. 1863; Flor. Eur. Alg. **3**: 321. 1868.

Filaments forming bright green or yellowish-green floccose masses or long skeins; cells usually cylindrical, rarely slightly constricted at the joints, 14–17 μ (generally 16.5, rarely 18 μ) in diameter, 1–2½ times as long; cell-wall rather thin; chromatophore pale green, often perforated or reduced to a reticulum; zoöspores rare; akinetes 18–22 μ (mostly 19.5 μ) in diameter, spheroidal, cuboidal, or almost cylindrical in shape (*pl. 24, f. 1–4*).

EXSIC.: Phyc. Bor. Am. *864. p.p.*, Pine Banks Park, Melrose, Mass., May 15, 1901, F. S. Collins.

Floating in streams and stagnant waters. One of the most abundant of simple confervae.

MASSACHUSETTS: Melrose, April (553); Framingham, May.

NEW YORK: Van Cortlandt Park, April to June (349B, 599, 286, 634); Bronx Park, June (605, 626).

NEW JERSEY: Grantwood, March to May (437, 529, 283); Edgewater, March (66A); Weehawken, May (409).

This species, *i. e.*, the name *Microspora floccosa*, has received two divergent and apparently incompatible interpretations as indicated in the list of synonyms. By Kützing, Rabenhorst, Kirchner, Wille, and Hansgirg, it has been described as having a diameter of 7.5–10 μ. By Cooke, Wolle, and De Wildeman, the diameter is increased to 14–17 or 18 μ. DeToni combines the two conceptions, making the diameter 10–18 μ. How this difference arose, it is impossible to say.

To determine just what the original form, *Prolifera floccosa* Vauch., was, is an equally difficult matter. Probably few students of our time would venture to take the confident attitude assumed by Agardh in relation to the identity of his *Conferva floccosa* and Vaucher's species.*

As a matter of fact such a barren figure and meager description as those of Vaucher are about equally applicable to any species of *Microspora* or to most of the members of this family. For further light on Agardh's conception of the species almost the only point of value is his reference to *Conferva fugacissima* Lyngb. as a synonym. Lyngbye's figure evidently represents a *Microspora;* it is the earliest illustration of the characteristic chromatophore structure. It is doubtful if this structure could have been so well

*Agardh remarks (Alg. Dec. 19. 1812), "Species nostra certe *Prolifera floccosa* Vauch. esse videtur. Convenit enim et descriptio et pulchra icon."

made out at that early time in a form much finer than ours, though it is quite possible that Agardh collected several different forms as *Conferva floccosa*, just as any beginner now using DeToni's Sylloge for authority would do.

When we come down to the middle of the nineteenth century, we can gain a somewhat more definite idea of Thuret's idea of the species. Unfortunately, to be sure, no data as to diameter and length of the cells are furnished; but there are beautiful figures, and from the magnification given with them, it may be estimated that Thuret's type was practically the same as our specimens in respect of size (*i. e.*, 13–16 μ).

To sum up: concerning the character of Vaucher's *Prolifera floccosa* practically nothing can be determined; of Agardh's *Conferva floccosa*, we may be reasonably sure that it belongs in the genus *Microspora*, and very likely it included our species; finally, there is no good reason to doubt that Thuret's *Microspora floccosa* is the same as our species. At all events we cannot prove that this conception, which has been adopted by several modern algologists, is not historically correct.

The uncertainty of the determinations of exsiccatae, or perhaps their mixed character, is exemplified in the fact that at least three numbers issued as *Microspora floccosa*, namely, Rabenh. Alg. Sachs. *356*, Aresch. Alg. Scand. *277*, and Tild. Am. Alg. *139A*, certainly contain *M. amoena*, a much larger species than any form of *M. floccosa*. The specimen issued by Miss Tilden, Am. Alg. *139B*, seems not much different from the smaller form of the European authors and is at least very nearly allied to our *M. tumidula*.

In *Microspora floccosa*, Rabenh. Alg. Eur. *1985*, which is partly referred to *Conferva abbreviata* (Rabenh.) Wille by the latter author, we have been able to find only a form corresponding to our definition of *M. floccosa*.

6. MICROSPORA WILLEANA Lagerheim; DeToni, Syll. Alg. **1**: 228. 1887; Flora, **72**: 207. *pl. 5. f. 1–19.* 1889

Vegetative cells cylindrical, 11–14 μ in diameter, ½–1½ (rarely 2) times as long: chromatophore variable, but often more dense and containing a larger amount of starch than in *M. floccosa*; cell-wall thin; akinetes 14–16.5 μ in diameter (*pl. 24, f. 5–7*).

EXSIC.: Phyc. Bor. Am. *619*, Melrose, Mass., March, 1894 (F. S. Collins).

Forming floccose masses in brooks and in stagnant waters.

MASSACHUSETTS: Ipswich, May (558B).

NEW YORK: Botanical Garden, May (376A, 407), June (609).

NEW JERSEY: Grantwood, April (530A); Edgewater, March (66B).

It is to be suspected that Scandinavian authors would include under this name the form which we have determined as *M. floccosa*. for in the vegetative condition there is the most perplexing similarity between the two forms. Indeed we have found forms corresponding to *M. floccosa*, *M. Willeana*, and *M. stagnorum* all mixed together, and forming what looked, at first sight, like a graded series of growth forms.

Nevertheless, in the fruiting condition, *M. floccosa* is easily distinguished from *M. Willeana* by its much larger akinetes, and it is probable that by more exact and extended field study they could be better distinguished when in the vegetative state.

This problem did not present itself until too late for more thorough field observations to be made in preparation for this paper.

7. MICROSPORA STAGNORUM (Kütz.) Lagerh. Ber. Deutsch. bot. Gesell. **5**: 417. 1887; Flora, **72**: 208. 1889. Hansgirg, Prod. Alg. Böhm. **2**: 222. 1893. DeToni, Syll. Alg. **1**: 229. 1889.

Conferva tenerrima stagnorum Kütz. Alg. Dec. *56*. 1833; Flora, **16**: 700. 1833.

Conferva stagnorum Kütz. Phyc. Gener. 257. 1843. Wille, Öfvers. Vet.-Akad. Förhand. **1881**[8]: 20. *pl. 9. f. 12–27. pl. 10. f. 50.* 1881. Hansg. Prod. Alg. Böhm. **1**: 75. 1886.

Gloeotila stagnorum Kütz. Phyc. German. 191. 1845.

Ulothrix tenerrima stagnorum Kütz. Spec. Alg. 346. 1849.

Ulothrix stagnorum Kütz. Tab. Phyc. **2**: *27. pl. 87. f. 2.* 1852. Rabenh. Krypt. Flor. Sachs. **1**: 264. 1863; Flor. Eur. Alg. **3**: 366. 1868.

Ulothrix tenerrima Rosenv. Bot. Tidssk. **11**: 121. *pl. 1. f. 1–14, 17–21.* 1879.

Filaments cylindrical; cells not at all inflated, about 8 μ (7.5–9.5 μ) in diameter, 1–3 times as long; chromatophore granular, not dense, usually not covering the cell-wall completely (*pl. 24, f. 12, 13*).

EXSIC.: Phyc. Bor. Am. 619. *p. p.*, Melrose, Mass., March, 1894 (F. S. Collins).

In stagnant water and in brooks, forming light green, floccose masses.

CONNECTICUT: New Preston, September (495).

NEW YORK: Botanical Garden, May (376B); Central Park, April (320).

NEW JERSEY: Grantwood, April (530), May (437); Edgewater, March (66 C).

The material collected in Connecticut (495) furnished interesting studies of the zoöspores. The cell-wall appeared to swell and soften, and exhibited little of the definite pulling apart in sections usually considered characteristic of this genus. The zoöspores, mostly one in a cell, were in active movement some time before they were released; to set them free the cell-wall seemed to dissolve into mucus and completely to disappear. The zoöspores had two cilia and a red eye-spot: this is contrary to the generally received description, in which it is said that the zoöspores have four cilia and no eye-spot. It is hard to believe that these were microzoöspores or gametes, formed only one in a cell as they were.

The above characterization of this species illustrates what may be regarded as a legitimate enlargement of an original description. Specimens have been found which correspond exactly to the description and type material of Kützing, having cells whose length is about equal to the diameter; by means of continued observation, it is discovered that such cells may grow to be three times as long as the diameter (or even four times as long according to Wille). By similar study the measurement of the diameter has been increased from 7.5 μ to 9.5 μ.

8. **Microspora tumidula** sp. nov.

Filaments forming dull green floccose masses or long skeins; cells nearly cylindrical but always slightly constricted at the dissepiments, 6.7–9.5 μ (generally about 7.5 μ) in diameter, 1–2 times

as long; chromatophore rather dense, covering most of the outer cell-wall; akinetes 8–11 μ in diameter, globose or flattened (*pl. 24, f. 8–11*).

Exsic.: *Microspora floccosa* Tild. Am. Alg. *139B*, Vancouver, 1898. (?)

In brooks and stagnant pools.

New York: Van Cortlandt Park, April (288, 348B), May (415B, 600, type), June (633); Botanical Garden, May (376B); East Chester, May (393B); Staten Island, April (332).

New Jersey: Hudson Heights, May (436), October (501); Grantwood, April (530D), May (283C, 429B, 579B); Undercliff, May (573A).

In respect of size, this species is similar to *M. stagnorum*, but it is always distinguished from the latter by the slight tumidity of the cells, and the more homogeneous character of the chromatophore. This seems at first sight like a somewhat superficial distinction, but in the type station, where it grows unmixed with any similar species, it has maintained a most constant character, and has always appeared so distinct that the only reasonable course is to regard it as a new species.

The larger forms of *Microspora tumidula* might possibly be identified with the *M. floccosa* of Kützing, Rabenhorst and Hansgirg, but as has been previously stated, this is probably not the true *M. floccosa*.

9. **Microspora quadrata** sp. nov.

Filaments light green, often in floccose masses; cells cylindrical, not at all constricted at the dissepiments, 5.5–7 μ (usually about 6.5 μ) in diameter, their length equal to the diameter or half as great; cell-wall very thin; chromatophore often covering the dissepiments as well as the outer wall, in an even, finely granular sheet (*pl. 24, f. 14, 15*).

Forming yellowish-green or sordid floccose masses, or fine cespitose growths, in springs, rivulets and watering-troughs.

Vermont: St. Johnsbury, winter culture (669); July (686).

Massachusetts: Melrose, May 12, 1901 (F. S. Collins, *4001, p. p.*).

Connecticut: Thomaston, May (560).

New York: Botanical Garden, May (423, type), June (443A),

September; Central Park, June (613A), October (664A); Pelham Bay Park, May (394B), September (486).

This species has been observed repeatedly in several stations, always showing a very constant character, and never mixed with other forms. It is the only *Microspora* that has been observed in the herbaceous grounds of the New York Botanical Garden, in a stream where *Spirogyra*, *Tribonema*, *Draparnaldia*, and *Myxonema* abound. It is well marked by the nearly square shape of the cells (in optical section), and by the fine bead-like edge of the chromatophore.

Young specimens collected in October showed a slightly narrowed basal cell imbedded in mucus, appearing somewhat like a small *Ulothrix* in the manner of attachment. It is probable that these plants germinated from akinetes which had lain dormant during the heat of the summer.

Microspora quadrata is perhaps very nearly allied to, if not identical with the *M. punctalis* of Rabenhorst and recent authors. There is considerable doubt, however, whether it is the *Conferva punctalis* of Dillwyn and it is almost certainly not *C. punctalis* Mueller (Nov. Act. Acad. Sci. Imp. Petrop. **3**: 90. *pl. 1. f. 1.* 1788) to which Dillwyn's figure and description supposedly applied. Mueller's species was probably a form belonging to the Mougeotiaceae. Agardh (Spec. Alg. 83. 1824) was of the opinion that *C. punctalis* Dillw. *pl. 51.* and Lyngb. *pl. 46*, was a species of *Zygnema*.

DOUBTFUL FORMS

MICROSPORA VULGARIS Rabenh. Krypt. Flor. Sachs. **1**: 245. 1863; Flor. Eur. Alg. **3**: 321. 1868.

Conferva vulgaris Kirchn. Krypt. Flor. Schles. **2**^{1}: 79. 1878. Wolle, F. W. Alg. 142. *pl. 21. f. 6–13.* 1887.

CONFERVA FARLOWII Wolle, Bull. Torrey Club, **6**: 140. 1887.

C. vulgaris Farlowii Wolle, F. W. Alg. 142. 1887.

Microspora Farlowii Rabenh. Alg. Eur. *2566.* 1878.

All the above as represented in the Wolle herbarium appear to be forms of *Tribonema*; also Tilden, Am. Alg. *21.* 1894, at least for the most part. Saunder's figure of *M. vulgaris Farlowii* (Flora of Neb. *pl. 22. f. 3.* 1894) is evidently *Tribonema.*

MICROSPORA FUGACISSIMA (Roth) Rabenh. Flor. Eur. Alg. **3**: 321. 1868.

Conferva fugacissima Roth, Cat. Bot. **1**: 176. 1797. (?) Wolle, F. W. Alg. 141. *pl. 120. f. 10–12.* 1887.

There is also very great doubt as to the true character of this form which, like most ancient species, has received a varied treatment. Mr. Wolle's specimens may be referred to *Tribonema bombycinum*.

MICROSPORA ABBREVIATA (Rabenh.) Lagerh. Ber. Deutsch. Bot. Gesell. **5**: 417. 1887.

The figures of *Conferva abbreviata* given by Wolle (F. W. Alg. *pl. 121. f. 18, 19.* 1887), like most of his illustrations of this genus, do not give any particular assistance in elucidating his notion of the species. Specimens in his herbarium bearing this name are identifiable as *Tribonema bombycinum*, hence his record may be disregarded.

This species is in such a state of confusion in European literature that it is difficult to know just how to dispose of it. Wille ('**81**) united *Conferva affinis abbreviata* Kütz. (Spec. Alg. 371. 1849) with *C. ochracea* Kütz. (Phyc. Germ. 202. 1845), and out of Rabenhorst's specimen of *C. affinis abbreviata* Kütz. (Alg. Sachs. *111.* 1851) made a new species, *C. abbreviata* (Rabenh.) Wille. This last name was transferred to *Microspora* by Lagerheim. DeToni combines both Wille's sets of synonyms under Lagerheim's name, but with Kützing's description.

The disposition of these names made by Wille is doubly untenable according to American rules: in the first place, *Conferva ochracea* Kütz. cannot stand in view of the earlier *C. ochracea* Roth (Cat. Bot. **1**: 165. 1797), and secondly, *Conferva abbreviata* (Rabenh.) Wille cannot be retained in the face of *Conferva abbreviata* Kütz. (Tab. Phyc. **3**: 14. *pl. 42. f. 8.* 1853).

The final disposition of these forms is a matter which can hardly be determined on this side of the Atlantic, and perhaps it is not a matter that concerns American algology.

MICROSPORA PUNCTALIS (Dillw.) Rabenh. Krypt. Flor. Sachs. **1**: 245. 1863; Flor. Eur. Alg. **3**: 321. 1868.

Conferva punctalis Dillwyn, Brit. Conferv. *pl. 51.* 1805. Kütz. Spec. Alg. 370. 1849. Wolle, F. W. Alg. 142. *pl. 121. f. 20, 21.* 1887. Not Mueller, Nov. Act. Acad. Sci. Imp. Petrop. **3**: 90. *pl. 1. f. 1.* 1788.

See *Microspora quadrata*.

MICROSPORA AMOENA forma THERMALIS Tild. Bot. Gaz. **25** : 92. *pl. 8. f. 12.* 1898.

The author remarks: "It is difficult to decide whether this plant should be classed as a *Conferva* or a *Microspora*, as the structure of the chloroplastids could not be made out." That this form having a diameter of 11–14 μ should be associated with a species ranging from 20–24μ, in a genus of such fine distinctions as *Microspora*, is a manifest absurdity. The form should have been "placed provisionally" among doubtful forms in the discoverer's herbarium, until its essential character could be determined.

MICROSPORA WEEDII Tild. Bot. Gaz. **25**: 93. *pl. 8. f. 13.* 1898; Am. Alg. *275.*

The figure furnishes a strong support to the suspicion that the author has no adequate conception of the difference between *Microspora* and *Tribonema;* the chromatophores certainly have the appearance of the latter. No satisfactory conclusion can be drawn from the poor specimens distributed.

IV. TRIBONEMA Derbes & Solier, Mém. sur Physiol. Alg 18. 1856

Conferva Lagerheim, Flora, **72**: 194–209. 1889. Not *Conferva* Linn. Sp. Pl. 1164. 1753.

Filaments at first attached by a special basal cell, later floating. Chromatophores disk-shaped, yellowish-green, without starch, but producing oil, two or several in a cell. Cell-wall thin, formed by deposition of layers composed largely of pectic acid with little cellulose. For the dispersal of the zoöspores, the cells pull apart from the middle, so that H-shaped sections are left.

Asexual reproduction through zoöspores, produced to the number of one to four in each cell; they are destitute of a red eye-spot, furnished with two cilia, one of which is short and reflexed.

Inhabitants of fresh water. Type *T. bombycinum* Derb. & Sol. [Etym. τρίβος, worn, and νῆμα, filament.]

The name *Conferva* is very ancient, going back to the time of Pliny. As a modern generic name it has received most varied treatment, and covered at different times very diverse groups of plants.

Under this name Linnaeus included a very large part of the

branching, as well as the simple, filamentous algae. He adopted the genus from Dillenius. The first species mentioned by Linnaeus, *Conferva rivularis*, is undoubtedly the oldest of his group, so far as the history of these ill-defined forms can be determined. This species, according to the synonymy of Linnaeus (Sp. Pl. 1164. 1753), is *Conferva fluviatilis, sericea vulgaris et fluitans* of Dillenius (Hist. Musc. 12. *pl. 2. f. 1.* 1741); this in turn is *Conferva Plinii* Dillen. (Cat. Plant. sponte Gissam nascentium, 199. 1719); the earliest description of *C. Plinii* that we have seen is in L'Obel's Plantarum Observationes, 664. 1576, but undoubtedly the name is of more ancient origin.

Now no one would imagine that the ancient herbalists or even Linnaeus could distinguish the numerous filamentous forms known to us only by the use of good microscopes. Indeed, the fact that Linnaeus described only two unbranched species is sufficient proof of this. *Conferva rivularis*, as collected by him, was very likely at one time a *Spirogyra* and at another an *Oedogonium*. This type species, however, as interpreted by the earlier algologists, *e. g.*, Dillwyn, Lyngbye and Mueller, is very evidently a form belonging to what is now known as *Rhizoclonium*, and has come down to us as *R. rivularis* (L.) Kütz. This identification is also confirmed by Linnaeus himself, who (Sp. Pl. Ed. 14. 1784) quotes the figure of *C. rivularis* from Flora Danica.

There is, therefore, a moderately strong argument in favor of employing the name *Conferva* for the genus *Rhizoclonium* if it is to be retained at all in modern algology. It would, perhaps, be better to reserve the name for the numerous species of confervoid algae whose character and proper position is not sufficiently known to permit their disposition in the more clearly defined modern genera.

At any rate, there is no warrant whatever for employing the name *Conferva* to designate the genus recognized under that name in Lagerheim's revision, for there is no evidence that these species were ever collected by Linnaeus, and certainly none of them were distinguished by him from other simple filamentous forms.

For Lagerheim's group of species, as for all genera, the adoption of a generic name based on a recognizable species, as a type, is essential. The earliest such name in the present case is *Tribo-*

nema Derbes & Solier (1856). This genus was based on a single species, *Conferva bombycina*, and in the diagnosis, for the first time in the history of the species, explicit mention was made of the most essential character, namely, the form of the chromatophores, although it had been previously suggested in the plates of Kützing. The method of zoöspore dispersal was also first described and illustrated by Derbes & Solier. There is, then, every reason for employing the name *Tribonema* as a memorial of the discernment of these authors.

Only a small number of forms is known to belong in this genus, and the inclusion by DeToni of a long array of species of *Conferva* and *Psichohormium* in the genus *Conferva* as emended by Lagerheim, is quite unwarranted. Probably many of these ought to be reduced to synonymy or placed on the list of indeterminables; certainly very few of them have been shown to possess the characters of the revised genus. The evil results of DeToni's wholesale grouping of species of ill-defined character may be seen in the very unreliable determinations of species by certain American writers who seem to have pinned their faith to his work. (See "doubtful forms" under *Tribonema* and *Microspora.*)

There are indications in Lagerheim's work that he contemplated reviving the name *Tribonema*, but apparently a too conservative instinct deterred him from abandoning *Conferva*.

There is very little doubt that the action taken by Borzi,* and supported by Bohlin, Blackman, and Wille, in removing this genus from the Ulothricaceae is entirely justified. The structure and composition of the cell-wall, the character of the chlorophyl, and the absence of starch all point to the close affinity of *Tribonema* with the Ophiocytiaceae.

As noted in the introduction, however, for present expediency in bringing into American literature, which has sadly confused *Microspora* and *Conferva*, the striking differences between these genera, the older arrangement has been here retained. Doubtless the easier course would have been to omit the genus, since some

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* Borzi, A. Boll. Soc. Ital. Mic. 1: 62–70. 1889.
Bohlin, K. Bih. Kong. Svensk. Vet.-Akad. Hand. 23^3: No. 3. 1897.
Blackman, F. F. Ann. of Bot. 14: 647–688. 1900.
Wille, N. Nyt Mag. for Naturvid. 39: 1–22. 1901.

may object to the displacement of a traditional name, though we believe this change is based on sound principles.

Synopsis of Species

Chromatophores usually numerous, cell-wall thin.
Diameter of filaments 6–11 μ. 1. *T. bombycinum.*
Diameter of filaments 3–6 μ. 1b. *T. bombycinum* f. *tenue.*
Chromatophores 2–4, symmetrically disposed, diameter of cells 5–6 μ. 2. *T. minus.*
Chromatophores numerous, large, cell-wall thicker, diameter of cells 11–16.5 μ. 3. *T. utriculosum.*

1. TRIBONEMA BOMBYCINUM (Agardh) Derb. & Sol. Mém. sur physiol. alg. 18. *pl. 4. f. 16–21.* 1856.

Conferva bombycina Agardh, Syn. Alg. Scand. 78. 1817; Syst. Alg. 83. 1824. Kütz. Spec. Alg. 371. 1849; Tab. Phyc. **3**: *pl. 44. f. 1, 2.* 1853. Rabenh. Flor. Eur. Alg. **3**: 323. 1868. Wille, Öfvers. Vet.-Akad. Förhand. **1881**[8]: *pl. 9. f. 41–43, pl. 10. f. 51–54,* 1881. Lagerh. Flora, **72**: 194–209. *pl. 6.* 1889. Cooke, Brit. F. W. Alg. 137. *pl. 53. f. 4.* 1883. Wolle, F. W. Alg. 142. *pl. 121. f. 8, 9.* 1887. DeToni, Syll. Alg. **1**: 216. 1889. Bohlin, Bihang Svensk. Vet.-Akad. Hand. **23**[3]: No. 3. *pl. 1. f. 1–14. pl. 2. f. 44–46.* 1897.

Conferva sordida Roth. Cath. Bot. **1**: 177. *pl. 2. f. 4.* 1797.(?) Dillw. Brit. Conferv. *pl. 60.* 1806.(?) Lyngb. Tent. Hyd. Dan. 138. *pl. 46D.* 1819.(?)*

Filaments forming a sordid, yellowish or green floccose mass, 6–11 μ in diameter when mature; cells cylindrical or somewhat inflated, 2–4 times as long as the diameter; chromatophores several in a cell, small or of moderate size, scattered or crowded, glistening oil-drops often numerous: cell-wall rather thin (*pl. 25, f. 1–3*).

EXSIC.: Phyc. Bor. Am. *620*, Malden, Mass., April, 1894 (F. S. Collins).

Common and widely distributed in stagnant and flowing waters, in spring and fall.

CONNECTICUT: Thomaston, April; Watertown, May (563); Plymouth, November (666).

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* *C. sordida* Dillw. was generally regarded as a synonym or variety of *C. bombycina* by the older authors. More recently it has been considered a *Microspora.* The original description and figures allow no final judgment as to the character of the species, hence it would be better if the name were dropped unless type specimens can be found. A specimen issued as *C. sordida* Rabenh. Alg. Sachs. *110* is *Oedogonium* sp.

NEW YORK: Central Park, May (128); Van Cortlandt Park, April (347); Bronx Park, June (605, 626C); New Rochelle, November (519).

NEW JERSEY: Undercliff, April (526); Englewood, May (430); Closter, October (499); Hudson Heights, May (435C).

NORTH CAROLINA: Salem, as *Conferva sordida* (Schweinitz).

1b. TRIBONEMA BOMBYCINUM forma **tenue** nom. nov.

Conferva bombycina forma *minor* Wille, Öfvers. Vet.-Akad. Förhand. 1879[5]: 65. *p. p.* 1879. Not *C. minor* Klebs.

Cells 3–6 μ in diameter, 2–12 times as long, usually very little if at all inflated; chromatophores small, numerous (*pl. 25, f. 4–6*).

EXSIC.: Phyc. Bor. Am. *C. bombycina* f. *minor* Wille, *621 A, B.* Bridgeport, Conn. (I. Holden).(?)

Usually growing mixed with *T. bombycinum.*

NEW YORK: Botanical Garden, April (341); Van Cortlandt Park, April (347), May (418).

NEW JERSEY: Closter, October (499A); Hudson Heights (435B).

From the fact that this form or aggregation of forms is generally found associated with *T. bombycinum* and at times appears to pass into the latter, it is to be suspected that it is simply a growth stage of that species. Since, however, the evidence for this view does not amount to actual proof, the present disposition is used as a matter of convenience in designating the small forms.

A form, which, when collected, appeared to be identical with *Conferva glacialoides* Wolle, developed, after a few days, into a condition corresponding to *T. bombycinum* f. *tenue* (*pl. 25, f. 4, 5*).

It is unfortunate that Wille's name cannot be retained for this series of forms for which it is well suited from the lack of definite characters associated with it. Because Klebs made a new species out of material identified by Professor Wille as belonging to his *Conferva bombycina* f. *minor*, there is necessity for the new form name proposed above.

2. **Tribonema minus** (Wille)

Conferva bombycina forma *minor* Wille, Öfvers. Vet. Akad. Förhand. **1879**[5]: 65. *pl. 14. f. 89. p. p.* 1879; *ibid.* **1881**[8]: 21. *pl.*

9. f. 36–40. pl. 10. f. 55, 56. 1881; Jahrb. wiss. Bot. **18**: *pl. 17. f. 64–68.* 1887. DeToni, Syll. Alg. **1**: 216. 1889.

Conferva minor Klebs, Fortpflanz. Alg. und Pilz. 347. *pl. 2. f. 1–8.* 1896.

Cells generally cylindrical, sometimes very slightly swollen, 5–6 μ in diameter, 2–4 or more rarely 6 times as long as broad; chromatophores 2–4 in each cell, arranged symmetrically in pairs for the most part (*pl. 25, f. 7, 8*).

Massachusetts: Melrose, April (550A, 552B).

Connecticut: New Preston, September (495A).

New York: Bronx Park, May (421), June (443C, 626B); Staten Island, April (328).

New Jersey: Undercliff, Bergen county, May (428), December (233).

After a number of observations and cultures, the distinctness of this species as defined by Klebs has been confirmed. It differs markedly in the character of the chromatophores from any form of *Tribonema bombycinum.*

3. **Tribonema utriculosum** (Kütz.)

Conferva utriculosa Kütz. Alg. Dec. *114.* 1836;* Spec. Alg. 372. 1849; Tab. Phyc. **3**: *pl. 44. f. 5.* 1853. Roemer, Alg. Deutsch. *pl. 5. f. 79.* 1845. Wille, Öfvers. Vet. Akad. Förhand. **1881**[8]: 22. *pl. 10. f. 67.* 1881. Wolle, F. W. Alg. 140. *pl. 120. f. 14–16.* 1887. DeToni, Syll. Alg. **1**: 217. 1889.

C. ventricosa Kütz. Phyc. Germ. 203. 1845.

Filaments long and often irregularly inflated, but sometimes cylindrical; cells 11–16.5 μ in diameter, 1½–6 times as long; chromatophores large and often crowded: cell-wall thicker than in the smaller species (*pl. 25, f. 9–11*).

Exsic.: Phyc. Bor. Am. *864. p. p.* (sub *Microspora floccosa*) Melrose, Mass., May 15, 1901 (F. S. Collins).

In slow or rapid streams, frequently in the outlets of swamps.

New York: Van Cortlandt Park, April (347), May (418).

New Jersey: Hudson Heights, May (435C); Grantwood, May (429, 573C, 579A).

This species probably includes forms sometimes identified as *Conferva bombycina major* Wille. The original diagnosis of the lat-

* Citation from Kütz. Spec. Alg. 372.

ter form (Wittr. & Nordst. Alg. Exsic. *519*. 1883) merely furnishes a statement of the diameter, 14–16 μ. We have seen no form with so great a diameter that could properly be associated with *Tribonema bombycinum*.

Tribonema utriculosum as above characterized does indeed approach *T. bombycinum* in respect to the diameter of the cells, but the thicker cell-wall and usually larger chromatophores, as well as an indefinable general appearance, sufficiently distinguish it from the smaller species. By repeated observation and cultural experiments, we have become convinced of the specific distinctness of the two forms.

It is a strange fact that none of these species of *Tribonema*, elsewhere common, have been found in Vermont during more than a year of collecting.

EXCLUDED FORMS

CONFERVA FONTINALIS Berk. Glean. Brit. Alg. *pl. 14. f. 1.* 1833. Wolle, F. W. Alg. 141. *pl. 120. f. 17–20.* 1887.

Microspora fontinalis DeToni, Syll. Alg. **1**: 230. 1889. Specimens bearing this name in the Wolle herbarium are certainly a *Rhizoclonium*, and probably the same is true of Berkeley's type. Berkeley supposed he was illustrating *Conferva fontinalis* Linn., but it is very doubtful if such was the case.

CONFERVA BOMBYCINA ELONGATA Tild. Am. Alg. *21* is a *Rhizoclonium* similar to Wolle's *C. fontinalis*.

CONFERVA SESQUIPEDALIS Tild. Am. Alg. *271*. is *Zygnema* sp.

CONFERVA SANDWICENSIS Tild. Am. Alg. *462*. Hawaii, 1900, is *Rhizoclonium* sp. showing the pyrenoids very clearly and giving a strong test for starch. All these examples of incorrect generic determination show how little the true *Conferva* (*Tribonema*) has been understood in this country.

See also doubtful forms of *Microspora*.

GENERA REMOVED FROM THE ULOTHRICACEAE

SCHIZOGONIUM Kütz. (Phyc. Gen. 245. 1843), including, according to the revision of Gay ('91), *Ulothrix*-like filaments which have stellate chromatophores and exhibit a strong tendency to longitudinal cell-division, and even to form an expanded thallus, is re-

moved from this family and placed with the Pleurococcaceae, because of the absence of reproduction by zoöspores.

SCHIZOMERIS Kütz. (Phyc. Gen. 247. 1843). We cannot accept the view of Professor Wille ('90) who disposes of this genus by placing it among the synonyms of *Ulothrix*. We have found *Schizomeris Leibleinii* Kütz. growing abundantly in a watering-trough and also in bright green *Spirogyra*-like masses at the edges of a creek near Long Branch, New Jersey, in midsummer, a time when all similar *Ulothrix* forms had disappeared. Although certain young filaments were almost indistinguishable from *Ulothrix zonata*, yet in all larger filaments the characteristic brick-like arrangement of the cells was very different from anything ordinarily found in *Ulothrix*. Most striking, however, was the manner of dispersal of the zoöspores; all the dissepiments in the upper part of the thallus appeared to be softened or broken down, and the masses of zoöspores escaped through the open funnel formed by the outer cell-wall. We have little question in regard to the validity of the genus *Schizomeris*, but as its affinity seems to be with the Ulvaceae rather more than with the Ulothricaceae, further treatment of it is reserved for another place.

GLOEOTILA Kütz. (Phyc. Gen. 245. 1843). Under this name have been placed various forms having affinities with *Ulothrix* and *Stichococcus*, some of which, because of insufficient characterization, cannot be determined with any certainty. Kützing's type of this genus was *G. oscillarina* (*Conferva oscillatorioides* Kütz. Alg. Dec.). This species was finally removed by its author to *Stigeoclonium* as *S. setigerum*, so that the genus *Gloeotila* must be abandoned.

Family **CHAETOPHORACEAE**

The thallus consists of a simple or more often branched filament, composed normally of a single series of uninucleate cells, which may all be of equal value, or some may be specialized as supporting or terminal structures and others as potential reproductive structures. The chromatophore in each vegetative cell is band-shaped, or it more or less completely lines the whole cell-wall, and generally contains one to many pyrenoids. Asexual reproduction by means of zoöspores, akinetes or aplanospores.

Sexual reproduction through conjugation of gametes similar in character, though sometimes differing in size.

Synopsis of Tribes and Genera

Tribe I. CHAETOPHOREAE

Plants attached at the base, erect, extensively branched, with more or less differentiation of supporting and reproductive portions (except in *Microthamnion*). All fresh-water plants.

Plants less than 1 mm. high, not setiferous. I. MICROTHAMNION.

Plants larger, branches generally pointed or setiferous.

Filaments fine, showing little difference in character of stem and branches. II. MYXONEMA.

Filaments fine, in tufts involved in dense gelatinous substances. III. CHAETOPHORA.

Filaments and main branches larger, bearing dense fascicles of small branchlets. IV. DRAPARNALDIA.

Tribe II. HERPOSTEIREAE

Plants microscopic, creeping on or within other algae or animals, without distinction between basal and apical cells, and without differentiation of supporting and reproductive portions.

Inhabiting salt water.

Plants tending to form an expanded thallus, growing on the surface of bryozoa. V. EPICLADIA.

Plants simply branched, endophytic within the membrane of *Elachista*. VI. ENDODERMA.

Plants bearing special setiferous cells, epiphytic on Phaeophyceae. VII. BOLBOCOLEON.

Inhabiting fresh water.

Plants composed of flask-shaped cells, bearing setae sheathed at the base. VIII. CHAETOSPHAERIDIUM.

Plants composed of globose or cylindrical cells, bearing setae bulbous at the base. IX. HERPOSTEIRON.

The genera of the Chaetophoreae are rather closely related, though *Microthamnion* and *Myxonema*, which are placed together, probably had a separate origin. The latter might be naturally derived from *Ulothrix*, while the former may have developed from a small *Stichococcus*-like ancestor. *Chaetophora* and *Draparnaldia* may easily be conceived of as developing from *Myxonema*.

The genera of the Herposteireae are a somewhat heterogeneous group, and perhaps have originated in different ways from protococcoid ancestors. Only *Epicladia* and *Endoderma* are closely related morphologically. *Herposteiron* seems to approach most nearly to the Coleochaetaceae, for it is not a great step from the

conjugation of the large and small gametes of the former to the oögamous fertilization of the latter.

I. MICROTHAMNION Nägeli; Kütz. Spec. Alg. 352. 1849. Kirchn. Krypt. Flor. Schles. **2**[1]: 70. 1878. Borzi, Nuova. Notarisia, **2**: 390. 1891. Schmidle, Hedwigia, **38**: 165–170. 1899.

Thallus minute, attached by a bulbous basal cell, much branched. Branches throughout of about the same diameter as the main stem. In the formation of a branch, a growth is pushed out at the upper end of a cell and the wall of separation is formed, not at this point, but some distance above in the branch. Cells cylindrical, the cell-wall very thin. Chromatophore a thin sheet, more or less completely covering the cell-wall, without pyrenoids but containing oil-drops.

Asexual reproduction through zoöspores formed in any cell (the basal excepted) to the number of 4 or 8; they are ovoid in shape, biciliate, without eye-spot, and germinate (apparently) directly after adhering to a substratum, without rhizoid formation.

Inhabitants of fresh water. Type *M. Kuetzingianum* Näg. [Etym. μικρός, small, and θαμνίον, a little bush.]

This genus has frequently been placed in close relation to *Trentepohlia* (*e. g.*, by Wille in Die natürlichen Pflanzenfamilien), because it has been supposed to have special terminal sporangia. In all the forms, however, with which we are familiar, any cell in the plant may produce zoöspores, and with less swelling of the filaments than in most of the Chaetophoreae. We have often seen many of the lower cells of a branch hyaline from the loss of the zoöspores, before they have escaped from the terminal cells. Hence the genus must occupy a position near to *Myxonema*. The remark of Chodat ('02) "Borzi pretend avoir vu les zoöspores biciliées (4–6 μ)" is unnecessarily discourteous, as there was every reason to expect that zoöspores would be found in these plants. Equally unjustifiable is his placing this genus in the Pleurococcaceae.

Synopsis of Species

Ramification dense, without distinction between main stem and branches.
1. *M. Kuetzingianum.*

Ramification more open, erect, the main stem distinguishable to the summit.
- Terminal cells not narrowed. 2. *M. strictissimum.*
- Terminal cells slightly tapering. 2b. *M. strictissimum macrocystis.*

1. MICROTHAMNION KUETZINGIANUM Nägeli; Kütz. Spec. Alg. 352. 1849; Tab. Phyc. **3**: *pl. 1.* 1853. DeToni, Syll. Alg. **1**: 256. 1889. Kirchn. Mik. Pflanz. *pl. 1. f. 10.* 1891. De Wild. Flor. Alg. Belg. 38. *f. 13.* 1896. (?) Schmidle, Hedwigia, **38**: 169. *pl. 7. f. 13–15.* 1899. Chodat, Beitr. Krypt. Flor. Schweiz. **1**[3]: 288. *f. 202, 203.* 1902. (?) Scarcely Wolle, F. W. Alg. *pl. 105. f. 1–4.* 1887.

Mature plants 60–200 μ tall, very densely and irregularly branched from the base, the main trunk soon disappearing in the ramifications; branchlets one- to several-celled, divergent, sometimes curved, not narrowed at the ends; cells cylindrical or sometimes subclavate, 3–4 μ in diameter, 2–4 (rarely 5–8) times as long; chromatophore bright green, covering nearly all the outer cell-wall (*pl. 26, f. 1; pl. 27, f. 2–4*).

EXSIC.: Phyc. Bor. Am. *568.* Greenhouse, Cambridge, Mass., 1899. (F. S. Collins).

Plants solitary or more often forming a thin bushy coating on small dead stems, etc. In watering troughs, in rivulets, and on dripping rocks.

CONNECTICUT: Watertown, May, (561B).

NEW YORK: Morningside Park, March to June (322, 352, 424, 532).

Chodat's description of the chromatophore as covering only two thirds of the circumference of the cell wall, as well as the open character of the branching in his figures do not agree with what is here (and by Schmidle also) considered the typical form of this species.

2. MICROTHAMNION STRICTISSIMUM Rabenh. Alg. Sachs. *829.* 1859; Krypt. Flor. Sachs. **1**: 236 (fig.), 266. 1863; Flor. Eur. Alg. **3**: 375. 1868. Schmidle, Hedwigia, **38**: 169. *pl. 7. f. 4, 5.* 1899.

Microthamnion Kuetzingianum strictissimum Hansg. Prod. Alg. Böhm. **1**: 91. 1886. DeToni, Syll. Alg. **1**: 258. 1889. Chodat, Beitr. Krypt. Flor. Schweiz, **1**[3]: 288. 1902.

Mature plants 300–600 μ tall, erect, branches generally alternate, the main trunks distinguishable even to the summit; branchlets erect or ascending, obtuse and not narrowed at the apex; cells cylindrical, 2.5–4 μ in diameter, 3–12 or even 15–20 times as long; chromatophore thin, pale green, not always encircling the cell (*pl. 26, f. 2–5*).

Forming a furry coating on dead straws and leaves, in stagnant water and in running water of a watering-trough; also in tufts on the sides of a rocky spring.

CONNECTICUT: Plymouth, March (524).

NEW YORK: East Chester, May (392B); Central Park, June (613B).

The opinion expressed by Schmidle that this species is quite distinct from *M. Kuetzingianum* is abundantly confirmed by comparison of American specimens. Most of the specimens on which the above description is based agree quite exactly with Rabenhorst's type material (Alg. Sachs. 829). The length of the cells as here given is greater than that given by Schmidle, but hardly greater then in some of Rabenhorst's plants.

The plants from Central Park are rather shorter and finer, so that we at first identified them as *Microthamnion vexator* Cooke (Grevillea, **11**: 75. 1882; Brit. F. W. Alg. 188. *pl. 73. f. 1.* 1883), but they are marked by a very strict or appressed habit of branching, while Cooke's figures represent a plant with very open branching. We have, therefore, included these plants in *M. strictissimum*, for there is no divergent character of sufficient importance to warrant making a new form. Indeed it is probable that *M. vexator* should not be maintained even as a variety of *M. strictissimum*, for though Cooke states that his plant is very much more slender than the latter species, the diameter he gives (3 μ) is not less than that of many plants of *M. strictissimum.* Furthermore, the measurements of *M. vexator* based on Cooke's original specimens, as given by Nordstedt (Svensk. Vet. Akad. Hand. **22**^{8}: 15. 1888), are so similar to those of the type material of *M. strictissimum*, that we fail to see how it is possible to separate the two forms.

MICROTHAMNION STRICTISSIMUM MACROCYSTIS Schmidle, Hedwigia, 38: 169. *pl. 7. f. 1–3.* 1899

Plants 300–800 μ tall, branching more open; branchlets ascending or spreading, slender, and tapering slightly toward the end; cells 2.5–3 μ (rarely 4 μ below) in diameter, 6–12, or 20 times as long; chromatophore pale and narrow, not encircling the cell, the tips of the apical cells hyaline (*pl. 27, f. 1*).

On dead leaves in a rain-water ditch in the hemlock grove, New York Botanical Garden, May, June (407, 608).

The name given to this variety by Schmidle is hardly appropriate, as the cells are no longer than many in *M. strictissimum*. The plant as here described agrees essentially with Schmidle's diagnosis, though the branching is perhaps less strict.

In the station above noted this form has appeared for a brief period in May and June during two seasons. It is not present in early spring, and the pool becomes dry upon the advent of warm weather.

II. MYXONEMA Fries, Syst. Orb. Veg. 343. *p. p.* 1825; Flor. Scan. 329. 1835

Stigeoclonium Kützing, Linnaea, **17**: 90. 1843; Phyc. Gen. 253. 1843.

Thallus covered with a thin slippery investment of mucus, consisting of a branched filament without great difference in respect to diameter between the main stems and the minor branches. Terminal branchlets pointed or frequently ending in long hyaline setae. Chromatophore a parietal, often laciniate band, zonate in the larger cells, nearly filling the smaller cells, inclosing several pyrenoids.

Asexual reproduction by means of 4-ciliate zoöspores having a red eye-spot, and akinetes which give rise to small 2-ciliate zoöspores, and through a palmella stage.

Sexual reproduction through conjugation of 2-ciliate gametes having a red eye-spot. Both gametes and zoöspores formed only in the vegetative cells of the branchlets.

Inhabitants of fresh water. Type, *M. lubricum* (Dillw.) Fries. [Etym. μύξα, mucus, and νῆμα, a filament.]

The fact that the genus *Myxonema*, as proposed by Fries, was composed of two diverse elements, probably accounts for its early supersession by the more homogeneous genera of Kützing. The first element comprised only the type (that is the first) species, *Conferva lubrica* (syn. *Draparnaldia* Ag.), a well-known branched form. The second element consisted of four unbranched species, *Conferva zonata* (Web. and Mohr), *C. compacta* Roth, *C. oscillatorioides* Agardh, and *C. dissiliens* Dillwyn, of which three are now recognized as species of *Ulothrix*, and the last as a desmid.

Ten years later Fries confirmed the genus, describing the species practically in the same order and adding two more. It is not surprising that such a grouping was made, for in the general appearance of the cells with the girdle-shaped chromatophore and the mucous character of the filaments, these two groups have more in common than many of the diverse elements at that time comprised in the genus *Conferva*. Now these four unbranched species were all placed in other genera before the establishment of Kützing's *Stigeoclonium* and the removal to it of *Myxonema lubricum*, our type. Hence whatever method of determining generic types is followed, that of residues or that of priority of position, since *Myxonema lubricum* was both the first species named under the genus and also the last to remain in it, the conclusion is inevitable that the genus *Myxonema* must stand upon this species. Though it is always an unfortunate necessity that compels the abandonment of a name long used for a large and comparatively homogeneous group like *Stigeoclonium* Kütz., reasons of sentiment cannot weigh in cases of this kind.

It should be noted that Rabenhorst ('47) at first adopted the genus *Myxonema* in practically the same composite sense as used by Fries, and that later, instead of keeping the name for part of the species, he abandoned it entirely for Kützing's genera *Stigeoclonium* and *Ulothrix*.

Fries (Syst. Orb. Veg. 345. 1825) quotes as a synonym of his new genus *Myxonema*, "*Naematrix* Fries, Stirp. Fems.," but we have been unable to find the latter name in the work quoted. Perhaps it was a manuscript name which was finally rejected in the publication of the Stirpium Agri Femsionensis Index, 1825–6.

Other authors refer to *Myxotrix* Fries, Stirp. Fems. 44, as a synonym of *Myxonema*, but the only species is *Myxotrix zonata* (presumably *Ulothrix zonata*); since no description or synonymy is there given, this name needs no further consideration.

Frequently one finds young or anomalous forms of *Myxonema*, which it is almost impossible to identify with any described species. On this account many specimens have been laid aside during the preparation of this work. It is very desirable that such young forms should receive continued attention, so that they may ultimately be associated with their proper species.

Although one may be very sure of the distinctness of species, it is a very difficult matter to construct a good key. It is hoped that the following may be of some assistance, though it is very far from satisfactory.

Synopsis of Species

Forms in which opposite branching predominates.
  Filaments 11–30 μ in diameter, branches often approximate.
    Lower cells 1–2 times as long as broad, walls thickened, branchlets usually short-pointed. 1. *M. lubricum.*
    Lower cells 2–5 times as long as broad, walls not thickened, branchlets more attenuate. 1b. *M. lubricum varians.*
    Lower cells 3–8 times as long as broad, branchlets pointed. 2. *M. amoenum.*
    Lower cells 4–8 times as long as broad, branchlets setiferous. 3. *M. flagelliferum.*
    Lower cells scarcely longer than broad, branchlets thorn-like, acute. 4. *M. subuligerum.*
    Lower cells 2–5 times as long as broad, much inflated. 5. *M. ventricosnm.*
  Filaments 7–10 μ in diameter, branches less crowded, transitional form.
    Lower cells 1–3 times as long as broad, branchlets tapering or setiferous. 6. *M. tenue.*
Forms in which alternate branching predominates.
  Filaments short, cespitose.
    Growing in thermal waters; diameter 7.5–12 μ. 7. *M. thermale.*
    Growing in water of ordinary temperature.
      Diameter 6–8 μ, branchlets obtuse or short-pointed. 8. *M. nanum.*
      Diameter 7–9 μ, branchlets erect, attenuate or setiferous. 9. *M. aestivale.*
      Diameter 11–14 μ, branchlets densely fasciculate, setiferous. 10. *M. glomeratum.*
  Filaments more or less elongated.
    Diameter 5–7 μ. 11. *M. attenuatum.*
    Diameter 8–11 μ. 12. *M. stagnatile.*
    Diameter 12–18 μ. 13. *M. subsecundum.*

1. MYXONEMA LUBRICUM (Dillw.) Fries, Syst. Orb. Veg. 343. 1825; Flora Scan. 329. 1835.

Conferva lubrica Dillw. Brit. Conferv. *pl.* 57. 1 March, 1806. Agardh, Syn. Alg. Scand. 92. 1817. (?) Lyngb. Tent. Hyd. Dan. 150. *pl.* 52. 1819. Not *C. lubrica* Roth. Cat. Bot. 3: 168. 1806 [=*Tetraspora lubrica*].

Draparnaldia tenuis elongata Agardh, Syst. Alg. 57. 1824.

Draparnaldia laxa Bory, Dict. class. d'hist. nat. **5**: 614. 1824.

Draparnaldia lubrica Crouan, Flor. Finist. 128. 1867.

Stigeoclonium lubricum Kütz. Phyc. German. 198. 1845; Spec. Alg. 354. 1849; Tab. Phyc. **3**: *pl. 6. f. 1.* 1853. Rabenh. Krypt. Flor. Sachs. **1**: 267. 1863. Kickx, Flore Crypt. Fland. **2**: 418. 1867. Berthold, Nov. Act. **40**: *pl. 15. f. 9, 11, 12, 14.* 1878.

Stigeoclonium tenue lubricum Rabenh. Flor. Eur. Alg. **3**: 377. 1868. Kirchn. Krypt. Flor. Schles. **2^1**: 68. 1878. Hansg. Prod. Alg. Böhm. **1**: 66. 1886. Wolle, F. W. Alg. 111. 1887. DeToni, Syll. Alg. **1**: 197. 1889. De Wild. Flor. Alg. Belg. 44. 1896.

Tufts 5 mm. to 3 dm. long, dark green and shining. Filaments much branched; branches single, opposite, or subverticillate, frequently two or more pairs approximate, springing from subglobose cells shorter than those of the rest of the filaments: branchlets very numerous, scattered, opposite, or in the upper part of the plant densely fasciculate, slender, usually only slightly tapering, ending in a short point or sometimes setiferous; lower cells generally somewhat swollen, thick-walled, 14–16.5 μ in diameter, ⅔–2 (rarely 2–4) times as long, containing a broad girdle-like chromatophore; diameter of branchlets 6–7 μ, the cells equal to or shorter than the diameter (*pl. 28, f. 1, 2*).

Exsic.: Phyc. Bor. Am. *866*, Malden, Mass., April 29, 1901. (F. S. Collins).

In brooks and watering-troughs, on stones, sticks, etc.

Massachusetts: Haverhill, April (554); Malden, cemetery, April (551, station same as of P. B. A. *866*).

Connecticut: Watertown, May (564); Litchfield, May (569B).

New York: New Rochelle, May (585), November (516, 517); West Chester, September (484), November (515); East Chester, May (389); Van Cortlandt Park, September (480); Manhattan, numerous stations, April to October.

New Jersey: Demarest, October (506); Englewood, October (666); Fairview, April (85A, 296); Undercliff, Bergen county, April (85B); Newark, November (514).

The synonymy gives an intimation of the varied treatment this species has received. Even Agardh was quite uncertain as to its

relation to his *Draparnaldia tenuis*, at one time making the latter a synonym under *Conferva lubrica*, and again making *Conferva lubrica* a variety of *D. tenuis*. After a very extended study of both these forms, there is no question in our opinion, of their distinctness, and we believe there is no doubt as to the correctness of the determination of the two as here described. Certainly there is no other American form that can be identified with Dillwyn's *Conferva lubrica*.

Kützing's figure of this species is only fair, and Berthold seems to be the only author who has particularly noted and correctly illustrated the small branch-bearing cells that are so characteristic of this and the rest of the forms of this group, though others have noted them in *Stigeoclonium flagelliferum*, and Kützing has given a hint of their presence in several forms. Miss Tilden ('96) has stated that, to her knowledge, such cells are a characteristic of no other species besides *S. flagelliferum*; possibly this is an indication that the western algal flora is considerably different from that of the east, for here there are at least seven well-marked forms in which these cells are a prominent feature.

Myxonema lubricum may in some sense be considered a standard or point of departure for the comparison of the other forms of this group. Though it reaches a greater length than any of the other members of the group, they are for the most part more developed in some feature. The variety *varians* is smaller but rather more branched; *M. subuligerum* has shorter cells, but more divergent and sharp-pointed branchlets; *M. amoenum* differs chiefly in the long cells of the main branches; *M. flagelliferum* might be considered a form of the last with attenuated, setiferous branchlets; *M. ventricosum* is a form in which the main cells are lengthened and inflated. These do not form an entirely progressive series, but are clearly related to *M. lubricum*. *M. tenue* is a much finer and somewhat simpler form, and might well be placed in the ancestral line of *M. lubricum*. The probable developmental relationship would be better indicated if the alternate branched species were placed first and *M. tenue* made to form a connecting link with the larger forms of the *lubricum* group. The present arrangement is simply more convenient for comparison.

1b. MYXONEMA LUBRICUM **varians** var. nov.

Tufts shorter, 5–15 mm. long; filaments somewhat more slender; branches single or opposite, generally approximate on a moniliform series of 3–10 shorter cells; branchlets slender, needle-shaped; lower cells cylindrical or somewhat swollen, rather thin-walled, 11–14 μ in diameter, 2–5 times as long (*pl. 33, f. 4, 5; pl. 28, f. 3, 4*).

On rocks and sticks, in rapid brooks and in watering-troughs.

MASSACHUSETTS: Medford, in a clay pit, May 7, 1901 (F. S. Collins, *3998*).

CONNECTICUT: Norwich, May (559); Thomaston, May (542).

NEW YORK: Central Park, May (384B), October (663); Flushing, August (456); West Chester, May (388); New Dorp, Staten Island, April, (334); Castleton Corners (330); Clove Lake (331); Concord (336, type).

NEW JERSEY: Undercliff, May (432); Shadyside, April (304B).

We have wavered between considering this form or collection of forms a mere growth stage of *M. lubricum* and a distinct species. The large number of specimens collected indicates that it is sufficiently important to be recognized. It is generally easily distinguished from the typical forms of *M. lubricum* by its smaller size (both in diameter and length of the filaments) and the longer, thin-walled cells. Though at times the branching is comparatively simple, as a rule the tendency is to accumulate more extensive series of branches than are commonly seen in *M. lubricum*. Where the variety has been found with typical forms of the species, it has seemed most distinct. In other cases the relationship has appeared to be so close that it is thought best, at least tentatively, to consider the smaller plant a variety of the larger.

In respect to diameter this form is intermediate between *Myxonema tenue* and *M. lubricum*, but in the matter of branching it is usually rather more developed than either of these; in some cases it approaches *M. amoenum*. Much simpler forms are also found, which must be associated with this variety. In our drawings of *Myxonema lubricum varians* and *M. tenue*, the diameter of the former has been represented as slightly smaller than it should be and that of the latter is slightly too large, in comparison with other species.

2. **Myxonema amoenum** (Kütz.)

Stigeoclonium amoenum Kütz. Phyc. German. 198. 1845; Spec. Alg. 355. 1849; Tab. Phyc. **3**: *pl. 6. f.* 2. 1853. Rabenh. Flor. Eur. Alg. **3**: 378. 1868. Wolle, F. W. Alg. 113. *pl. 98. f. 4.* 1887. DeToni, Syll. Alg. **1**: 202. 1889.

Cespitose, light green, about 5 mm. long. Filaments much branched, branches mostly opposite throughout, frequently two or three pairs approximate, arising from short angular cells; branchlets tapering and pointed but usually not setiferous. Cells of main branches nearly cylindrical, frequently slightly inflated, 3–8 times as long as the diameter, above 2–4 times as long as the diameter, and finally in the branches subequal; chromatophore thin and narrow below; diameter of lower cells 11.5–16 μ, at base of branchlets 6.5–8 μ (*pl. 29*).

Attached to a flag stem, floating in the river. Ipswich, Mass., May, (558A). "Mountain springs and pools, Penn." F. Wolle.

3. MYXONEMA FLAGELLIFERUM (Kütz.) Rabenh. Deutsch. Krypt. Flor. 2^2: 100. 1847

Stigeoclonium flagelliferum Kütz. Phyc. Germ. 198. 1843; Spec. Alg. 355. 1849; Tab. Phyc. **3**: *pl. 10. f. 1.* 1853. Rabenh. Flor. Eur. Alg. **3**: 378. 1868. Wolle, F. W. Alg. 112. *pl. 97. f. 1.* 1887. Scarcely Tilden, Minn. Bot. Stud. **1**: 629. *pl. 31–35.* 1896.

Tufts 5–20 mm. long, bright green; branches mostly in pairs, often 2–4 approximate on short somewhat globose cells; branchlets flagelliform, attenuate into long setae; cells of the lower branches 14–18 μ in diameter, 4–8 times as long, cylindrical or slightly inflated, at the base of the branchlets 9–10 μ.

EXSIC.: Phyc. Bor. Am. *408*, Bridgeport, Conn., Dec. 1895. (I. Holden).

This species seems to differ from *M. amoenum* chiefly in having a slightly larger diameter and setiferous terminal branches.

Miss Tilden, at the end of her elaborate and painstaking study of *Pilinia diluta* Wood and *Stigeoclonium flagelliferum* Kütz., writes as follows:

"To avoid adding to the confusion alreading existing in the genus *Stigeoclonium*, it is thought best to place the plant which

has been undergoing investigation in the above species although it is not entirely in agreement with it. It does agree in one of the main points, that of forming groups of short, branch-bearing cells. * * * As this is a characteristic of no other species, to my knowledge, it seems necessary to connect it with that name."

Possibly the plant treated by this author was an abnormal form of *Stigeoclonium flagelliferum*; it certainly was not typical of the species. The point to be noted is, that because it agreed in *one* of the main points, the author found it necessary to connect it with that name, and thereupon proceeded to rewrite the description of one of the best characterized species in the genus in such a way as to fit her plant, changing some important points so as to transform the character of the description—and all this to avoid adding to the existing confusion!

It might be remarked parenthetically, that in almost every instance where Wolle stretched a description in order to squeeze his specimen into it, his form has to be questioned, and less confusion would have resulted by the addition of several new species.

It is inconceivable that one having any familiarity with Kützing's plates—and lacking such familiarity one ought never to attempt to treat this genus—should have described the branches of *S. flagelliferum* as "rarely opposite," thus removing it from the group of species with which it is really most closely associated.

The fact that *Pilinia diluta* Wood represents a stage in the life history of some specimens of *Stigeoclonium* is most admirably worked out in Miss Tilden's paper. The conclusion, however, that *Pilinia* as a genus is only a form genus to be included in *Stigeoclonium* is wholly unwarranted. It overlooks the true *Pilinia*, *P. rimosa* Kütz., and the other marine forms, *Acroblaste* and *Chaetophora maritima*, that have been associated with it.

4. **Myxonema subuligerum** (Kütz.)

Stigeoclonium subuligerum Kütz. Spec. Alg. 354. 1849; Tab. Phyc. **3**: *pl. 5. f. 1.* 1853.

S. protensum subuligerum Rabenh. Flor. Eur. Alg. **3**: 378. 1868. (?) DeToni, Syll. Alg. **1**: 200. 1889.

More or less tufted, 5 mm. or more in length; filaments very much branched; main branches opposite or approximate, spread-

ing, frequently elongated, beset with numerous, mostly opposite, divaricate branchlets; branchlets thorn-like, tapering from a thick base to an acute point, often attenuate into rather short setae; cells throughout cylindrical, about as long as broad, or a little longer or shorter, filled with the dense chromatophore; diameter of the main branches about 14 μ (12–16 μ), of the branchlets about 8 μ (6–9 μ) at the base (*pl. 30*).

In brooks and rills.

NEW YORK: Bronx Park, June (607, 627); Botanical Garden, May (374, 422), June (629).

NEW JERSEY: Hudson Heights, April (309).

Though our specimens average rather larger than the diameter given by Kützing (11–12.6 μ), yet in general character they seem exactly to correspond with his description and figures. Taking into account the fact that Kützing's description was based on dried specimens, the agreement is certainly as close as could be expected. Rabenhorst seems quite to have misunderstood the nature of this species or of *Stigeoclonium protensum* for the two are conspicuously incompatible; the latter is an alternate-branched form, while this species is extreme in its development of the opposite type of branching.

5. **Myxonema ventricosum** sp. nov.

Cespitose, 5–10 mm. long; filaments much branched, branches mostly opposite, borne on small subglobose cells, often 2–4 pairs approximate, ascending; branchlets alternate, opposite or subfasciculate, short, tapering slightly to a rounded apex, sometimes prolonged into a rather obtuse seta; cells below very strongly inflated, 2–5 times as long as the central diameter, above shorter and less inflated, in upper branches cylindrical, about as long as the diameter or shorter; diameter of lower cells 14–16.5 μ at the dissepiments, 27–30 μ in the center, 45–110 μ long; diameter of branchlets at base 6–8 μ (*pl. 31*).

On stones in the bed of a rapid brook. Cresskill, New Jersey, 1 May 1900 (359).

In the character of the upper branches this species resembles *Myxonema lubricum* and *M. amoenum*. The cells of the main branches, however, are very much more inflated than either of those forms. It is perhaps nearer to *Stigeoclonium insigne* Nägeli (Pflanz-phys. Untersuch. **1**: 36. *pl. 1*. 1855), a beautiful species

which appears to have escaped the notice of DeToni, but rather than crowd it unduly into that species, it seems better to establish a new species.

Wolle's figure of *Stigeoclonium nudiusculum* shows considerable similarity to our plant; it is certainly not what it purports to be.

Myxonema ventricosum was abundant at the time noted, but when sought for, less than a month afterward, none could be found. The plant is so marked a form, however, that there can be no doubt of its distinctness.

6. MYXONEMA TENUE (Ag.) Rabenh. Deutsch. Krypt. Flor. 2^2: 100. 1847

Draparnaldia tenuis Agardh, Alg. Dec. 40. 1814; Syst. Alg. 57. 1824; Icon. Alg. Eur. *pl. 38.* 1828–35. Hass. Brit. F. W. Alg. 123. *pl. 11. f. 2.* 1845. Derb. & Sol. Ann. Sci. Nat. Bot. III. **14**: 267. *pl. 33. f. 1–6.* 1850.

Stigeoclonium tenue Kütz. Phyc. Gener. 253. 1843; Phyc. German. 197. 1845; Spec. Alg. 353. 1849; Tab. Phyc. **3**: *pl. 3. f. 1.* 1853. Rabenh. Krypt. Flor. Sachs. **1**: 268. 1863; Flor. Eur. Alg. **3**: 377. 1868. Kirchn. Krypt. Flor. Schles. 2^1: 68. 1878; Mik. Pflanz. 11. *pl. 1. f. 19.* 1891. Hansg. Prod. Alg. Böhm. **1**: 66. 1886. Wolle, F. W. Alg. 111. *pl. 96. f. 11.* 1887. Cooke, Brit. F. W. Alg. 189. *pl. 73. f. 3.* 1883. DeToni, Syll. Alg. **1**: 197. 1889. De Wild. Flor. Alg. Belg. 44. 1896.

Myxothrix tenuis Trevis. Alg. Ten. Udin. 16. 1844.

Tufts 5–10 mm. long, bright green; filaments much branched, slender; main branches solitary or opposite, usually not more than two pairs adjacent; branchlets numerous, scattered or opposite, short, erect, thorn-like, tapering to an acute point or finely setiferous; cells cylindrical or slightly swollen, 7–10 μ (generally 8 μ) in diameter, 1–3 times as long (sometimes longer below); branchlets 5–6 μ in diameter at the base, cells about as long as the diameter (*pl. 32*).

In brooks and watering-troughs.

VERMONT: St. Johnsbury, August (643).

MASSACHUSETTS: Melrose, May 16, 1901 (F. S. Collins, *4007*).

NEW YORK: Botanical Garden, August to October (458, 497), June (612, 631); Manhattan, June (615, 640, 625), September (478).

This species, together with *M. lubricum*, seems to have undergone a gradual course of misinterpretation, until by DeToni it is explicitly described as not setiferous, while the variety *lubricum* is said to be setiferous. As a matter of fact the reverse is nearer the truth. The beautiful figures of Agardh, as well as his original description, clearly represent a form in which the branchlets are often more than subulate; they may be even rather long setiferous. On the other hand the branchlets of *M. lubricum* are more often short-pointed. It is, of course, a matter of some difficulty to determine certainly the true character of an old species like this, but the plants on which our description has been based agree as closely as possible with the above-mentioned original figure and description.

Kützing's figure does not appear to be characteristic. In our judgment it resembles the young forms which are commonly found and which cannot certainly be identified with any particular species. Perhaps this figure has given rise to the incorrect notion of the species that has become prevalent.

The species is variable, the branching less dense and less uniformly opposite than in other members of the *lubricum* group, and it therefore forms a point of transition to the alternate-branched species.

The best specimens of *M. tenue* seem to reproduce *M. lubricum* in miniature, but there is no evidence that the two species intergrade; in fact where both forms have been found growing together they have appeared most distinct.

7. **Myxonema thermale** (A. Braun)

Stigeoclonium thermale A. Braun; Kütz. Spec. Alg. 353. 1849; Tab. Phyc. **3**: *pl. 2. f. 4.* 1853. Rabenh. Flor. Eur. Alg. **3**: 376. 1868. Cooke, Brit. F. W. Alg. 189. *pl. 73. f. 2.* 1883. Wolle, F. W. Alg. 111. *pl. 96. f. 1.* 1887. DeToni, Syll. Alg. **1**: 201. 1889.

Stigeoclonium Borminanum Anzi, Erb. Critt. Ital. *1034.*

Draparnaldia uniformis Ag. Flora, **10**: 635. 1827; Icon. Alg. Eur. *pl. 37.* 1835. (?)

Bright green, somewhat creeping at the base, branches numerous, branchlets rather remote, alternate or opposite, erect or somewhat divergent, attenuated upward to an acute apex; cells 7.5–12 μ in diameter, 1–2 times as long, in the branchlets 3–5 times as long.

In warm springs and hot water waste from mills, etc.

Wolle's figure seems so well in accord with the species, that there is no good reason for question in regard to it. *Draparnaldia uniformis* has usually been considered a variety of *Stigeoclonium tenue*, but both in respect of general character and habitat, it appears to be more closely allied to this species.

8. **Myxonema nanum** (Dillw.)

Conferva nana Dillw. Brit. Conferv. *pl. 30.* 1803. Web. & Mohr, Grossbrit. Conferv. *pl. 30.* 1805. Lyngb. Tent. Hyd. Dan. 149. *pl. 52. A.* 1819.

Draparnaldia sparsa Hassall, Ann. & Mag. Nat. His. **11**: 428. 1843.

D. nana Hassall, Brit. F. W. Alg. 124. *pl. 10. f. 4.* 1845.

Stigeoclonium nanum Kütz. Spec. Alg. 354. 1849. Cooke, F. W. Alg. 190. *pl. 74. f. 2.* 1883. Wolle, F. W. Alg. 112. *pl. 96. f. 10.* 1887. Saunders, Flora of Neb. **1**: 64. *pl. 18. f. 1.* 1894.

Plants 2–3 mm. high; branches and branchlets alternate, tapering somewhat, obtuse or short-pointed; cells 6–8 μ in diameter, and 1–2 times as long.

Exsic.: Phyc. Bor. Am. *867*, Iroquois, South Dakota, September, 1897 (De Alton Saunders).

The figures given by Wolle and Saunders are sufficiently like those of Dillwyn and Cooke, so that the identification of their plants can hardly be questioned. At the same time, it appears very probable that this species is only a young state of some other. The specimen from South Dakota particularly has this appearance and the lack of strongly marked characters in the diagnosis points to the same conclusion.

9. **Myxonema aestivale** sp. nov.

Light green, growing in dense tufts 2–5 (rarely 15) mm. long; filaments radiating from a palmelloid base; branches dichotomous or alternate, erect; branchlets few, short, erect, very slender, frequently approximate near the summit, often attenuate into fine setae; cells thin-walled, somewhat swollen, 7–9 μ (rarely 11 μ) in diameter, 2–6 times as long, above about equal to the diameter (*pl. 33, f. 1–3*).

Forming a cespitose covering on the edge of iron fountains and watering troughs.

VERMONT: St. Johnsbury, April (673, 674).

CONNECTICUT: Thomaston, September (493).

NEW YORK: Botanical Garden, June (630), September (479), October (498, 652, 653); Manhattan, July to November (459, 489, 483, 487, 510, 463, 654).

This species appears to be very similar in its general character to *Stigeoclonium radians* Kütz. and *S. fastigatum* Kütz., but from the fact that it never attains the size of these two species, and appears to be fully mature and not a young form, we have felt obliged to consider it an undescribed species. It is distinguished from the forms mentioned, aside from its smaller size, by longer cells, less abundant branches and less developed setae. This is essentially a summer form; we have not found it in New York earlier than June, but it is rather abundant in several stations through the summer and early autumn.

10. **Myxonema glomeratum** sp. nov.

Tufts about 8 mm. long, from a dense palmelloid base; filaments radiating, bearing few, alternate branches below; branches above alternate or rarely opposite, more or less densely penicillate-fasciculate, particularly at the summit, tapering into an acute or long setiferous point; cells of main branches 11–14 μ in diameter, 2–7 times as long, cylindrical or slightly swollen, chromatophore broadly zonate; cells of branchlets 6–8 μ in diameter, 1–2 times as long, chromatophore dense (*pl. 34*).

Attached to twigs in a nearly stagnant pool, and in the iron basin of a fountain.

NEW YORK: East Chester, May (390, 591); Central Park, June (623).

This species is very similar in the character of the terminal branching to *Stigeoclonium fasciculare* Kütz. (not Wolle), but it differs so much from that form in the long cells of the main branches that it must be considered as distinct, at least until further evidence as to Kützing's species is obtained.

Great diversity in the density of the branching may be seen even in a single tuft, and from this circumstance one might suspect this to be an abnormal form of some other species. Because, however, it has maintained in character in the same station, under changed conditions in successive seasons, it has seemed impossible to refer it to any other species.

11. **Myxonema attenuatum** sp. nov.

Tufted, or forming dark green lubricous skeins, 10 mm. to 4 dm. long; dichotomously divided near the base into numerous long, slender filaments, sparsely branched above; branchlets short, spinescent or flagelliform, solitary or 2–3 arising at the same point, less often opposite, tapering into an acute point or into a very finely attenuated seta; cells cylindrical, 5–7 μ in diameter, mostly 2–5 times as long, chromatophore thin and somewhat broken (*pl. 35*).

In running water of watering-troughs.

VERMONT: St. Johnsbury, March to November (642, 646, 667, 670, 685).

CONNECTICUT: Thomaston, February to May (522, 540B, 547).

This species is capable of growing to a greater length than is recorded for any other species in the genus. It forms fine silken tufts on the bottom or sides, and long skeins in the overflow on the outside of iron or wood watering-troughs. Sometimes it stretches in fine cobweb-like strands across a tub just below the surface of the water, and resembles in appearance a fine *Ulothrix*. Usually one does not see the character of the basal branching except in the shorter tufts.

The plant was fully grown in February (although it was not visible in December) and seemed to disappear from the two Connecticut stations where it was observed, before summer. In Vermont it is probable that it was growing from early spring until destroyed by ice in autumn.

12. **Myxonema stagnatile** sp. nov.

Floccose, floating; filaments somewhat elongated, bearing at widely separated intervals, solitary or opposite branchlets, which are short, thorn-like, often curved, tapering to a sharp point or attenuate into a long seta; cells 8–11 μ in diameter, 1–3 times as long (occasionally one or two cells above the point of branching, each a length of 6 times the diameter); branchlets 7–9 μ in diameter at the base (*pl. 36, f. 1, 2*).

Floating in confervoid masses in pools and ponds.

MASSACHUSETTS: Melrose, April, 1901 (553), May, 1902 (676).

NEW YORK: Williamsbridge, April (292).

This form resembles *Stigeoclonium protensum* as represented by Thuret and some others, but most authors describe that species as larger and having long drawn out branches, a characterization which corresponds more closely to Dillwyn's species.

13. **Myxonema subsecundum** (Kütz.)

Conferva subsecunda Kütz. Alg. Dec. *146*. 1836.

Stigeoclonium subsecundum Kütz. Phyc. Gen. 253. 1843; Spec. Alg. 352. 1849; Tab. Phyc. **3**: *pl. 1. f. 2*. 1853. Rabenh. Flor. Eur. Alg. **3**: 376. 1868. Wolle, F. W. Alg. 112. *pl. 99. f. 2*. 1887. (?)

Filaments elongated, about 16 μ (12–18 μ) in diameter; very sparsely branched below, branches never opposite; cells cylindrical, very slightly constricted at the dissepiments, 3–10 times as long as the diameter; some branches elongated with cells of the same character as those of the main filament, others shorter with cells 2–3 times the diameter; branches attenuated toward the apex (*pl. 36 f. 3*).

Pleasantville, New Jersey, May 15, 1891 (F. S. Collins). "Collected by H. W. Ravenel in rice field ditches, South Carolina." F. Wolle.

DOUBTFUL FORMS

STIGEOCLONIUM NUDIUSCULUM Kütz. Tab. Phyc. **3**: 4. *pl. 15. f. 2. pl. 16. f. 1*. 1853. Rabenh. Flor. Eur. Alg. **3**: 380. 1868. Wolle, F. W. Alg. 113. *pl. 98. f. 1, 2*. 1887.

Draparnaldia nudiuscula Kütz. Phyc. Germ. 231. 1845.

The form described and illustrated under this name by Wolle is quite incompatible with the species of Kützing. He seems not to have noticed the essential phrase in the description of Rabenhorst, "ramulis superioribus plerumque ternis fasciculatim aggregatis." Certainly there is no fasciculate branching in Wolle's form: it appears to be more like our *Myxonema ventricosum.*

STIGEOCLONIUM PROTENSUM (Dillw.) Kütz. Phyc. Germ. 198. 1845; Spec. Alg. 355. 1849; Tab. Phyc. **3**: *pl. 18. f. 2.* 1853. Wolle, F. W. Alg. 112. *pl. 101. f. 1–4.* 1887.

Conferva protensa Dillwyn, Brit. Conferv. *pl. 67.* 1806.

Possibly Wolle's figures represent this species, but as no specimens that could be identified with it have been seen, this form must be considered questionable.

STIGEOCLONIUM FASCICULARE Kütz. Bot. Zeit. **5**: 177. 1847; Tab. Phyc. **3**: *pl. 8. f. 1.* 1853. Rabenh. Flor. Eur. Alg. **3**: 380. 1868. Wolle, F. W. Alg. 114. *pl. 99. f. 1.* 1887.

The form illustrated by Wolle is very different from Kützing's species. The phrase in Rabenhorst's description "filis ramisque dichotomis," has been made by Wolle to read "branching mostly *opposite dichotomous*," thus changing entirely the character of the description, to say nothing of bringing together two incompatible features.

Stigeoclonium fasciculare Phyc. Bor. Am. *67* is similar to Wolle's form in its opposite branching and appears to be nearly related to *Myxonema lubricum.*

In the specimen issued under this name by Miss Tilden (Am. Alg. *20*) we can find nothing but *Chaetophora elegans.*

We have seen no American specimens that could properly be considered *Stigeoclonium fasciculare,* though our *Myxonema glomeratum* approaches it in general character.

STIGEOCLONIUM FASTIGATUM Kütz. Spec. Alg. 356. 1849; Tab. Phyc. **3**: *pl. 11. f. 1.* 1853. Wolle, F. W. Alg. 114. *pl. 100. f. 1.* 1887. Saunders, Flora of Neb. **1**: 64. *pl. 18. f. 2.* 1894.

STIGEOCLONIUM RADIANS Kütz. Spec. Alg. 354. 1849; Tab. Phys. **3**: *pl. 7. f. 2.* 1853. Wolle, F. W. Alg, 115. *pl. 102. f. 4.* 1887.

STIGEOCLONIUM LONGIPILUS Kütz. Phyc. Germ. 198. 1845; Tab. Phyc. **3**: *pl. 7. f. 1.* 1853. Wolle, F. W. Alg. 115. *pl. 100. f. 2, 3. pl. 102. f. 1–3.* 1887.

These three species are so similar in character that it is difficult to discover adequate points of distinction. We have seen no American specimens that could well be identified with any of these species, and as Wolle's descriptions are somewhat modified in every case, we feel obliged to question his determinations of these forms. *Stigeoclonium longipilus minus*, as issued in Phyc. Bor. Am., *865*, corresponds to Hansgirg's description, but it is doubtful if a form like this, only 4–6 μ in diameter ought to be considered a variety of a species 11–14 μ in diameter; this may be a young stage of *S. longipilus.*

III. CHAETOPHORA Schrank, Der Naturforscher, **19**: 124–126. 1783; Baier. Flor. **2**: 489–490. 1789

Rivularia Roth, Cat. Bot. **1**: 212–214. 1797.

Myriodactylon Desvaux, Journ. de Bot. **2**: 307. 1809.

Thalli forming globular or elongated colonies, consisting of filaments arising in a dense mass from a palmelloid base and closely held together in an elastic, resistant, gelatinous substance. Filaments repeatedly branched, of nearly equal diameter throughout, the ultimate branchlets more or less fasciculate, often terminating in long hyaline setae. Chromatophore a parietal band inclosing one to several pyrenoids.

Asexual reproduction by means of biciliate zoöspores, formed in the cells of the branchlets. Akinetes may be formed (apparently) in all cells.

Inhabitants of fresh water. Type, *C. globosa* Schrank. [Etym. χαίτη, hair; φορέω, to bear.]

Until 1812 the species which are now placed in this genus generally bore the name *Rivularia* Roth. At that time Agardh, in reviving the old genus *Chaetophora* Schrank, either made no attempt to identify the type species or could not.

The genus *Chaetophora* was founded on two species. Of these, the second *C. lobata*, is plainly to be identified with our *C. incrassata*. The determination of the first or type species, *C. globosa*, is not so simple a matter. This was based on Müller's *Conferva stellaris, filamentis e basi orbiculari parallelis* (Der Naturforscher

7: 189. *pl. 3.* 1775). We believe that any one would naturally connect Müller's figures with one of our globose species of *Chaetophora;* yet it is a curious fact that this plant, or at least one bearing the name *Conferva stellaris.* Müller, sixty years later became the type of Kützing's genus *Stigeoclonium.*

Now whether this species was really a *Stigeoclonium* or, what we understand by *Chaetophora*, is, of course, an important question. For if it was the former, then the name *Chaetophora* would have to supersede *Myxonema* and *Stigeoclonium*, while the species we now know as *Chaetophora* would have to be restored to *Rivularia.*

There is every reason, however, to believe that such a confusing readjustment will never be necessary; for a careful study of Müller's paper, supported by a comparison of the treatment of his species by early authors, is sufficient to convince one that the *Conferva stellaris filamentis, etc.*, is really to be identified with one of our species of *Chaetophora.* Indeed by the ingenious process of juggling with names used by some authors, Schrank's type might be identified with *C. pisiformis*, but we do not regard the actual specific identification as sufficiently certain to warrant the displacement of Roth's name.

It should be noted that Roth's type of *Rivularia* was *R. Cornu-Damae* [= *Chaetophora incrassata*], and that the schizophyceous species which form the genus now called *Rivularia* were added later and have no real right to the name. If the modern tendency toward multiplication of genera should reach *Chaetophora*, there would be a necessity for reviving the name *Rivularia* for the forms now grouped under the name *Chaetophora incrassata*, so that another generic name ought to be given to the Schizophyceae now bearing the name *Rivularia.*

Synopsis of Species

Colonies of filaments subglobose or tuberculose.	
Branching lax and spreading, fasciculate at the summit.	1. *C. elegans.*
Branching erect, fasciculate at the summit.	2. *C. pisiformis.*
Branching erect, not fasciculate at the summit.	3. *C. attenuata.*
Colonies of filaments extended, irregularly lobed or laciniate.	4. *C. incrassata.*

1. CHAETOPHORA ELEGANS (Roth) Agardh, Disp. Alg. Suec. 42. 1812; Syst. Alg. 27. 1824. Lyngb. Tent. Hyd. Dan. 192 (excl. syn.) *pl. 65.* 1819. Hassall, Brit. F. W. Alg. 127. *pl. 9. f. 3, 4.* 1845. Kütz. Spec. Alg. 532. 1849; Tab. Phyc. **3**: *pl. 20. f. 1.* 1853. Rabenh. Flor. Eur. Alg. **3**: 384. 1868. Wood, F. W. Alg. 210. *pl. 6. f. 5.* 1873. Cooke, Brit. F. W. Alg. 194. *pl. 78. f. 2.* 1883. Wolle, F. W. Alg. 116. *pl. 103. f. 4–10.* 1887. DeToni, Syll. Alg. 183. 1889.

Rivularia elegans Roth, Neue Beitr. Bot. **1**: 269. 1802.* (Ann. of Bot. **1**: 259. 1805.)

Batrachospermum intricatum Vauch. Hist. Conferv. 117. *pl. 12. f. 2, 3.* 1803. DeCandolle, Flore Franç. **2**: 58. 1815.

Chaetophora longipila Kütz. Phyc. Germ. 261. 1845; Tab. Phyc. **3**: *pl. 17. f. 1.* 1853. Wolle, F. W. Alg. 118. *pl. 103. f. 16, 17.* 1887. (?)

C. cervicornis Kütz. Tab. Phyc. **3**: 5. *pl. 119. f. 2.* 1853.

C. elegans cervicornis Rabenh. Flor. Eur. Alg. **3**: 384. 1868. DeToni, Syll. Alg. **1**: 183. 1889.

C. elegans longipila Hansg. Prod. Alg. Böhm. **1**: 70. 1886. DeToni, Syll. Alg. **1**: 183. 1889.

Colonies globose or more often tuberculose, 1–10 mm. in diameter, light green in color, the gelatinous substance rather soft, frequently confluent; filaments radiating from the center, dichotomously or trichotomously branched, penicillate at the summit; branches lax and somewhat spreading, above sometimes crowded and erect; terminal branchlets short pointed or setiferous; cells of main branches about 8 μ (6–11 μ) in diameter, 3–10 times as long; terminal cells 5–7 μ in diameter (*pl. 37*).

Attached to leaves, sticks and stones, in brooks and stagnant waters.

NEW YORK: Van Cortlandt Park, April–June (344, 602, 636); Botanical Garden, April (81, 274, 354), May (387), June (441, 442); East Chester, May (392).

NEW JERSEY: Hudson Heights, April (302); Grantwood, March–May (4, 13, 367, 440); Greenwood Lake, September (465).

WASHINGTON: Whidley Island, July, 1901 (N. L. Gardner).

There is to be found in this species every degree of variation, from tiny globose specimens up to large tuberculose and con-

* Citation from Roth, Cat. Bot. **3**: 337. 1806.

fluent forms. These large forms have probably been generally referred to *Chaetophora tuberculosa*, but extended observations in field and laboratory have convinced us that they are merely growth forms of *C. elegans*.

The presence or absence of terminal setae should not be made a character for separation of varieties in this species, for plants which possess them early in their growth, lose them later.

A suspicion was expressed by Wolle, that *C. elegans*, *C. pisiformis* and *C. tuberculosa* might be stages in the growth of one plant, because he found it difficult at times to separate them. One is inclined to question whether Wolle understood the true character of the species, particularly *C. pisiformis*. The separation of the species is not a matter of cell measurements, for these are subject to the greatest variation. Practically the only distinction between *C. elegans* and *C. pisiformis* as described by Roth, that holds good generally, is in the much more open and loose branching of the former. The issues of the two species in American exsiccatae are badly confused.

2. CHAETOPHORA PISIFORMIS (Roth) Agardh, Disp. Alg. Suec. 43. 1812; Syst. Alg. 27. 1821. Grev. Scot. Crypt. Flor. **6**: Synop. 40. *ibid.* **3**: *pl. 150.* 1825 (as *C. elegans*). Kütz. Spec. Alg. 532. 1849; Tab. Phyc. **3**: *pl. 18. f. 3.* 1853. Harvey, Ner. Bor. Am. **3**: 70. 1857. Rabenh. Flor. Eur. Alg. **3**: 383. 1868. (?) Cooke, Brit. F. W. Alg. 193. *pl. 78. f. 1.* 1883. (?) Wolle, F. W. Alg. 116. *pl. 103. f. 1–3, 12–15.* 1887. Kirchn. Mik. Pflanz. 11. *pl. 2. f. 20.* 1891. Saunders, Flora of Neb. *pl. 13. f. 5.* 1894. (?)

Rivularia pisiformis Roth, Neue Beitr. Bot. **1**: 272. 1802.* (Ann. of Bot. **1**: 261. 1805.)

Colonies globose or tuberculose, 2–5 mm. in diameter, usually dark green, rarely confluent, the gelatinous substance dense and resistant; filaments densely radiating from the center, strict, dichotomously or less frequently trichotomously branched, branches erect or appressed throughout; terminal branchlets slender, acute or sometimes setiferous; cells of main branches about 6–7 μ (5.5–8 μ) in diameter, 3–6 times as long; terminal cells 4–6 μ in diameter (*pl. 38, f. 1*).

* Citation from Cat. Bot. **3**: 338. 1806.

In brooks, chiefly attached to pebbles and rocks.

MASSACHUSETTS: Middlesex Fells, July (449).

NEW YORK: Bronx Park, May (372); Van Cortlandt Park, May (603).

NEW JERSEY: Hudson Heights, May (434); Demarest, October (507).

Though sometimes appearing to be very closely related to *C. elegans*, nevertheless, in general this species is very distinct from that form. It usually has a darker green color, and firmer more resistant gelatinous substance; in fact it is often a difficult matter to separate or crush the closely packed filaments. Though size is a very variable quantity, in general the filaments of *C. pisiformis* are more slender than those of *C. elegans*, the branches are always erect, and the terminal branchlets usually less numerous. This species appears to be less inclined to grow in quiet waters; we have nearly always found it in a strong current.

3. **Chaetophora attenuata** sp. nov.

Colonies globose or slightly verrucose, solitary, 2–5 mm. in diameter, bright green, involved in dense and very resistant gelatinous substance; filaments dichotomously or trichotomously branched from the base, always erect and subparallel, not fasciculate at summit; terminal branchlets finely pointed or setiferous; cells of the main filament 5–5.5 μ in diameter, 5–10 times as long; branch-bearing cells broad and often bifurcated at the top (*pl. 39*).

On rocks and pebbles at the edge of ponds.

CONNECTICUT: Plymouth, reservoir, September (491, type).

NEW JERSEY: Greenwood Lake, September (466).

This species, like *C. pisiformis*, possesses a more resistant gelatinous investment, and a stricter habit of branching than *C. elegans*, but its filaments are much finer and more attenuated than those of either of the other species. It is characterized by great regularity in its branching above, and by abundant rhizoid development, rhizoids being pushed out even below the palmelloid basal cells. This appears to be a summer form, for all traces of it disappear before the end of October, and none appeared in the spring up to the middle of May.

It is a curious fact that *Chaetophora pisiformis* and *C. attenuata* are at times infested by rotifers, while *C. elegans* seems never to be

so troubled; possibly the peculiar consistence of the gelatinous investment makes the two former species better fitted for sheltering animal inhabitants. Furthermore in both stations *C. attenuata* harbored the same species of rotifer, while a different species is found in *C. pisiformis.*

4. **Chaetophora incrassata** (Hudson).

Ulva incrassata Hudson, Flor. Ang. 572. 1778 [Ed. 2]; Eng. Bot. *pl. 967.* 1802.

Chaetophora lobata Schrank. Der Naturf. **19**: 126. 1783; Baier. Flor. **2**: 491. 1789.

Rivularia Cornu-Damae Roth, Cat. Bot. **1**: 212. *pl. 6. f. 2.* 1797; Ann. of Bot. **1**: 256. 1805.

Rivularia endiviaefolia Roth, Römer's Archiv f. Bot. **1**^{3}: 51. 1798; Cat. Bot. **2**: 249. 1800; Ann. of Bot. **1**: 257. 1805.

Tremella palmata Hedwig, Com. Trem. Nost. 70. *f. 4–7.* 1798.

Conferva incrassata Bosc, Bull. Sci. Soc. Phil. **2**: 145–6. *pl. 11. f. 2. A–C.* 1800.

Batrachospermum fasciculatum Vauch. Hist. Conferv. 116. *pl. 13. f. 1, 2.* 1803.

Myriodactylon incrassatum Desvaux, Journ. de Bot. **2**: 307. 1809.

Chaetophora endiviviaefolia Agardh, Disp. Alg. Suec. 42. 1812. Lyngb. Tent. Hyd. Dan. 191. *pl. 65.* 1819. Hassall, Brit. F. W. Alg. 125. *pl. 9. f. 1, 2.* 1845. Kütz. Spec. Alg. 532. 1849; Tab. Phyc. **3**: *pl. 21.* 1853. Harvey, Ner. Bor. Am. **3**: 69. 1853. Rabenh. Krypt. Flor. Sachs. **1**: 272. 1863. Wood, Hist. F. W. Alg. 210. 1873. Cooke, Brit. F. W. Alg. 194. *pl. 78. f. 2.* 1883. Wolle, F. W. Alg. 117. *pl. 104.* 1887.

Rivularia incrassata Purton, Midl. Flor. **3**: 179. 1817. [*fide* Cooke.]

Chaetophora Cornu-Damae Agardh, Syst. Alg. 29. 1824. De-Toni, Syll. Alg. **1**: 187. 1889. Saunders, Flora of Neb. **1**: 64. *pl. 17. f. 1.* 1894.

Chaetophora clavata Hornem. Flor. Dan. *pl. 1728. f. 2.* 1831.

Batrachospermum Americanum Schweinitz, MS.

Chaetophora Schweinitzii Bailey, MS.

Colony irregularly extended and lobed or laciniate, 2 mm. to 1 dm. long, consisting of elongated filaments held together by mucus in sheaf-like fascicles; branches alternate or secund, bearing densely crowded terminal fascicles of branchlets which are usually long-setiferous; cells of filaments 8–16 μ in diameter, 2–6 times as long, cylindrical or inflated; terminal branchlets often torulose and curved, 6–11 μ in diameter, cells 1–2 times as long (*pl. 38, f. 2, 3*).

EXSIC.: Phyc. Bor. Am. *68*. Middlesex Fells, Mass., May, 1890 (F. S. Collins). Hauck & Richt, *387*. Middlesex Fells, Mass., April, 1890 (F. S. Collins). Wittr. & Nordst. *510*. Bethlehem, Pa., 1882 (F. Wolle). Tild. Am. Alg. *10*. Hennepin county, Minn., 1894; *267*. King county, Washington, July, 1897; *268*. Chester county, South Carolina, April, 1896 (H. A. Green).

On stones, sticks and leaves in brooks.

VERMONT: Alburg, June (682).

MASSACHUSETTS: Cambridge, 24 May 1891 (L. M. Underwood).

CONNECTICUT: New Haven, May, 1885 (W. A. Setchell).

NEW YORK: Van Cortlandt Park, April to June (98, 345, 346, 407, 601, 636).

NEW JERSEY: Grantwood, April, May (94, 122, 282, 366, 577).

SOUTH DAKOTA: June 28, 1897 (D. Griffiths).

MONTANA: Great Falls, August, 1885 (F. W. Anderson).

The reference by Hudson to the excellent figures of Vaillant (Botanicon Parisiense, 56. *pl. 10. f. 3.* 1727) and Dillenius (Hist. Musc. 51. *pl. 10. f. 10.* 1741) leaves no doubt as to the identity of his *Ulva incrassata* with the plant that has been known as *Chaetophora endiviaefolia* or *C. Cornu-Damae;* hence the necessity for reviving this ancient name which antedates Roth by nearly twenty years.

The two manuscript names above quoted are here inserted because they have been erroneously referred to *Draparnaldia opposita*. (See discussion under that species.)

The numerous varieties of this species that have been proposed chiefly by Kützing and Rabenhorst appear to be for the most part at least, mere growth forms, and therefore they are not enumerated here.

This species is so very different in form from the globose species of *Chaetophora* that one unfamiliar with it is likely to think of it as an abnormally fasciated *Draparnaldia*.

DOUBTFUL FORMS

CHAETOPHORA TUBERCULOSA (Roth) Agardh, Syn. Alg. Scand. 129. 1817. Wolle, F. W. Alg. 116. *pl. 103. f. 11.* 1887.

Rivularia tuberculosa Roth, Neue Beitr. Bot. **1**: 285. 1802 (ref. from Cat. Bot. **3**: 341. 1806).

There has been some diversity in the interpretation of this species. Roth's description, notably the clause, "Ramis ramulisque approximatis patulis sparsis," indicates a plant differing from the erect-branched form illustrated by Kützing (Tab. Phyc. **3**: *pl. 19. f. 1*) and Hansgirg (Prod. Alg. Böhm. **1**: 71. *f. 30.* 1886). These erect-branched forms correspond with our idea of what *C. pisiformis* should be.

Kützing's earlier figure (Phyc. Gen. *pl. 10. f. 2*) and European exsiccatae (Kütz. Alg. Dec. *92.* Rabenh. Alg. Eur. *1077.* Hauck & Richter, *384.* Wittr. & Nordst. *610b*) seem to harmonize better with Roth's description, but can hardly be separated from tuberculose forms of *C. elegans* common with us.

We should hardly wish to do away entirely with *C. tuberculosa* on this evidence, but we can obtain no assurance of its occurrence in this country, and possibly all specimens may be referred to *C. elegans* and *C. pisiformis*.

CHAETOPHORA MONILIFERA Kütz. Spec. Alg. 896. 1849; Tab. Phyc. **3**: *pl. 20. f. 2.* 1853. Rabenh. Flor. Eur. Alg. **3**: 384. 1868. Wolle, F. W. Alg. 118. *pl. 103. f. 18, 19.* 1887.

The figure furnished by Wolle evidently represents only a zoösporiferous state of one of our ordinary species. The specimen issued by Miss Tilden (Am. Alg. *9*) is of no greater value; it does not show the large thick-walled cells to be seen in Rabenhorst's specimen of *C. monilifera*.

The suggestion of Schmidle (Hedwigia **36**: 9–12. 1897), that this species, as well as *C. pachyderma* Wittr., is only a form of *C. elegans* in which the cells have largely developed into akinetes, appears to contain much of truth. If, however, we accept the view that these are only developmental forms, their names should

not be given varietal rank as was done in the case of *C. elegans pachyderma* (Wittr.) Schmidle, *l. c.*

CHAETOPHORA CALCAREA Tilden, Am. Alg. *11.* 1894; Minn. Bot. Stud. **1**: 229. 1895; Bot. Gaz. **23**: 102. *pl. 8, 9. f. 6, 7.* 1897.

There is no character, besides that of secreting lime, furnished in the description of this species that particularly distinguishes this plant from species like *C. elegans* and *C. pisiformis*, and that character, judging from the frequence of its occurrence in different forms, can hardly, in our opinion, be considered a point of strong specific importance.

IV. DRAPARNALDIA Bory, Ann. Mus. Hist. Nat. **12**: 399 ff. 1808

Charospermum Link, Epist. de Alg. 5. 1820.

Thallus covered with a soft, gelatinous investment, attached to the substratum by rhizoids developed from the lower cells and often at points of branching; main filament and primary branches large, bearing, as well as the smaller branches, numerous crowded fascicles of small branchlets which often terminate in a long hyaline seta. Chromatophore, in the cells of the larger branches, a parietal band, sometimes perforated or reticular, containing numerous pyrenoids; in the small cells of the branchlets, a layer covering the inner surface of the cell-wall, containing few pyrenoids.

Asexual reproduction by means of 4-ciliate zoöspores furnished with a red eye-spot, which germinate immediately, and by means of akinetes; both are formed only in the smaller cells.

All inhabitants of fresh water. Type species *Draparnaldia mutabilis* Bory (= *D. glomerata*). [Named in honor of the French botanist, J. P. R. Draparnaud.*]

Synopsis of Species

Rachis clearly traceable to or beyond the summit of the fascicles of branchlets.
- Fascicles mostly erect, lanceolate, elongated at the apex. 1. *D. plumosa.*
- Fascicles ascending or spreading, broadly ovate, acuminate. 2. *D. acuta.*

Rachis soon lost in the ramification of the orbicular, spreading fascicles.
- Cells of main branches much inflated, chromatophore narrow. 3. *D. glomerata.*
- Cells of main branches cylindrical, chromatophore broad. 4. *D. platyzonata.*

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* The name of this genus has been written *Draparnaudia* by DeToni and some other recent authors. As the personal name, however, was sometimes written Draparnauld, it has been thought best to adhere to Bory's spelling, until good reason is shown for the change.

1. DRAPARNALDIA PLUMOSA (Vauch.) Agardh, Disp. Alg. Suec. 42. 1812; Alg. Dec. 38. 1814; Syst. Alg. 58. 1824. Lyngb. Tent. Hyd. Dan. 189. 1819. Hassall, Brit. F. W. Alg. 121. *pl. 12. f. 1.* 1845. (?) Kütz. Spec. Alg. 357. 1849; Tab. Phyc. **3**: *pl. 14. f. 1.* 1853. Rabenh. Flor. Eur. Alg. **3**: 382. 1868. Harvey, Ner. Bor. Am. **3**: *72.* 1857. Wood, Hist. F. W. Alg. 208. 1873. Kirchn. Krypt. Flor. Schles. **2**^{1}: 67. 1878; Mik. Pflanz. 11. *pl. 1. f. 18.* 1891. Cooke, Brit. F. W. Alg. 193. *pl. 75. f. 1, 2.* 1883. Wolle, F. W. Alg. 109. *pl. 94.* 1887. DeToni, Syll. Alg. **1**: 191. 1889. Saunders, Flora of Neb. **1**: 65. *pl. 19. f. 1.* 1894.

Conferva mutabilis Roth., Cat. Bot. **1**: 197. 1797. (?) Dillw. Brit. Conferv. *pl. 12.* 1802. (?)

Batrachospermum plumosum Vauch. Hist. Conferv. 113. *pl. 11. f. 2.* 1803. DeCand. Flor. Franç. **2**: 59. 1815.

Draparnaldia hypnosa Bory, Ann. Mus. Hist. Nat. **12**: 405. *pl. 35. f. 2.* 1808.

Conferva lubrica Eng. Bot. *pl. 2087.* 1809. Not Dillwyn.

Tufts 1–15 cm. long; branches spreading or ascending, solitary or opposite, the fascicles of branchlets single, opposite or whorled, generally crowded, erect or ascending, lanceolate to ovate-acuminate in outline, their branchlets erect or ascending, the rachis usually much extended at the apex, or at least easily distinguishable from other branchlets; ultimate branchlets subulate, or setiferous; cells of larger branches generally nearly cylindrical, somewhat constricted at the joints, 45–70 μ in diameter, 1–3 times as long, terminal branchlets 6–10 μ in diameter; chlorophyll band ¼–⅓ as wide as the length of the cell, proportionally broader in the small branches (*pl. 40, f. 1. 2*).

EXSIC.: Tild. Am. Alg. *12*, Minneapolis, Minn., August 1894, Chester, S. C., February, 1896 (H. A. Green). Phyc. Bor. Am. *21*, Bridgeport, Conn., February, 1892 (I. Holden).

Attached to sticks and stones in running water.

VERMONT: St. Johnsbury, August (644); North Hero, June (680).

MASSACHUSETTS: Haverhill, April (555).

CONNECTICUT: Derby, April (539).

NEW YORK: Central Park, April (317, 319), May (383, 595); Syracuse, June, 1884 (L. M. Underwood).

NEW JERSEY: Hudson Heights, April (304); Demarest, November (218); Englewood, May (360).

PENNSYLVANIA: Chester county, 1890 (H. M. Richards).

INDIANA: Greencastle, October, 1893 (L. M. Underwood).

MONTANA: Great Falls, September, 1885 (F. W. Anderson).

This species usually has closely set, plumose fascicles of densely crowded branchlets. More slender or less branched forms are often called *D. plumosa pulchella* Rabenh., but there is some reason to believe that Kützing's *D. pulchella* may be a more distinct form.

Some of the material above quoted from Haverhill, Mass., seems to correspond to Kützing's description of *D. pulchella* in having longer, more ventricose cells. Without further collection, however, we cannot regard it as more than a young stage of *D. plumosa*.

2. DRAPARNALDIA ACUTA (Ag.) Kütz. Phyc. Germ. 230. 1845; Spec. Alg. 356. 1849; Tab. Phyc. **3**: *pl. 13. f. 2.* 1853

D. glomerata acuta Agardh, Syst. Alg. 59. 1824. Rabenh. Flor. Eur. Alg. **3**: 382. 1868. DeToni, Syll. Alg. **1**: 192. 1889. DeWild. Flor. Alg. Belg. 43. 1896.

Tufts 1–8 cm. long; branches ascending or spreading, solitary or opposite, somewhat moniliform; the fascicles of branchlets single, opposite or whorled, generally somewhat crowded, ascending or spreading, broadly ovate to lance-ovate and acuminate in outline; branchlets in the fascicle ascending, the rachis usually extended at the apex; ultimate branchlets subulate or setiferous, often curved; cells of larger branches somewhat inflated, or above nearly cylindrical, 50–90 or more, rarely 110 μ in diameter, 1–2 times as long, chlorophyll band half as wide as the cell-length or narrower; diameter of terminal branchlets 6–10 μ.

EXSIC.: Tild. Am. Alg. *12 C.* (as *D. plumosa*), Forest Grove, Ore., February, 1896 (F. E. Lloyd.) (?)

In brooks, rills, and semi-stagnant waters.

CONNECTICUT: Thomaston, May (541, 546, 565, 566).

NEW YORK: Bronx Park, May (370, 408); East Chester, May (391), November (518).

NEW JERSEY: Hudson Heights, May (433); Cresskill, May (358); Undercliff, May (572).

This form has usually been considered a variety of *D. glomerata*, but it appears to be equally or more closely related to *D. plumosa*. It frequently exhibits, to be sure, the spreading habit of branching, the broad fascicles of branchlets, and the inflated

lower cells, which are characteristic of *D. glomerata;* but even in these points, especially toward the end of the branches, it often resembles more closely *D. plumosa*, while it invariably shows, in common with the latter, a very distinct, long rachis in the fascicles of branchlets. This last character is of greater phylogenetic importance than the others. It is very easy to derive the simpler forms of *D. plumosa* from one of the larger *Myxonema* species, and then through such an intermediate form as *D. acuta*, to arrive at *D. glomerata*.

Draparnaldia plumosa and *D. glomerata* as here restricted are very readily distinguished. When *D. acuta* is made a variety of the latter, the species immediately become confused and separation is at times difficult. The present disposition contributes much to clearness. Repeated observation at the same station has convinced us that *D. acuta* is, in spite of its variability, a reasonably distinct form. If, however, it is to be reduced from specific rank, it should undoubtedly, in our judgment, be made a variety of *D. plumosa* rather than of *D. glomerata*.

3. DRAPARNALDIA GLOMERATA (Vauch.) Agardh, Disp. Alg. Suec. 41. 1812; Alg. Dec. 37. 1814; Syst. Alg. 58. 1824. Lyngb. Tent. Hyd. Dan. 189. *pl. 64.* 1819. Hassall, Brit. F. W. Alg. 120. *pl. 13. f. 1.* 1845. Roemer, Die Alg. Deutsch. *pl. 2. f. 25.* 1845. Kütz. Spec. Alg. 356. 1849; Tab. Phyc. **3**: *pl. 12.* 1853. Harvey, Ner. Bor. Am. **3**: 72. 1857. Rabenh. Flor. Eur. Alg. **3**: 381. 1868. Wood, Hist. F. W. Alg. 207. 1873. Cooke, Brit. F. W. Alg. 191. *pl. 76. f. 1, 2.* 1883. Wolle, F. W. Alg. 108. *pl. 92.* 1887. Saunders, Flora of Neb. **1**: 65. *pl. 19. f. 2.* 1894.

Batrachospermum simplex DeCand. Bull. Sci. Soc. Phil. **3**: 21. *p. p.* 1802.*

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*DeCandolle quotes as synonyms for his *Batrachospermum simplex*, *Conferva gelatinosa* Girod, Rech. Chim. et Mic. 33. *pl. 5.* 1802, and Vaucher's *Conferva inédite*, Bull. Sci. Soc. Phil. **2**: *pl. 13. f. 4* 1802. The former is *Batrachospermum*, the latter is undoubtedly *Draparnaldia glomerata*, but a specific name founded, in this way, on two diverse elements without sufficient description to be recognizable apart from the synonyms can hardly displace such a well-grounded name as *Draparnaldia glomerata*. It is noticeable that under the latter species, Vaucher makes no reference to his earlier figure.

Batrachospermum glomeratum Vauch. Hist. Conferv. 114. *pl. 12. f. 1.* 1803. DeCand. Flor. Franç. **2**: 59. 1815.

Conferva Chara Roth, Cat. Bot. **3**: 285. 1806.

Conferva mutabilis Eng. Bot. *pl. 1740.* 1807.

Draparnaldia mutabilis Bory, Ann. Mus. Hist. Nat. **12**: 402. *pl. 35. f. 1 b. d.* 1808.

Generally densely tufted, 1–8 cm. long; filaments repeatedly branched, branches spreading or horizontal, solitary or opposite, moniliform, bearing very numerous scattered, opposite, or whorled fascicles of branchlets, fascicles mostly set at right angles to the branch and often sessile, broadly orbicular to elliptical in outline, their branchlets spreading, the rachis of the fascicle disappearing in the ramification or at least not more prominent at the summit than other branchlets, ultimate branchlets densely crowded, subulate, often setiferous; cells of larger branches strongly inflated, 50–90 or sometimes 125 μ in diameter, their length about equal to (½–2 times) the diameter; chlorophyll band rather narrow or half as broad as the diameter, proportionately broader or even filling the cell in the smaller branches; diameter of terminal branchlets 6–9 μ (*pl. 40, f. 3, 4*).

EXSIC.: Phyc. Bor. Am. *20*, Bridgeport, Conn. (I. Holden). Tild. Am. Alg. *13*, St. Paul, Minn., September 1894.

Attached to grass, sticks, stones and earth, in active or quite waters.

VERMONT: St. Johnsbury, April (671), July (684), October (649).

MASSACHUSETTS: Melrose, April (552); Rowley, May (556); Worcester, 1887 (G. E. Stone).

CONNECTICUT: Thomaston, May (544, 545).

NEW YORK: Bronx Park, April (14, 80, 270, 338, 339); Van Cortlandt Park, April (79, 342).

NEW JERSEY: Grantwood, Bergen county, March (4, 62), April (91), May (364); Hudson Heights, March (70), April (303).

This species is very well distinguished from *D. plumosa* and *D. acuta* by its broadly rounded fascicles of branchlets, in which the rachis is quickly lost in the branching.

The forms known as *D. glomerata distans* (Kütz.) Hansg., and *D. glomerata remota* Rabenh. appear to be no more than growth stages of the species. The description of *D. glomerata maxima* Wood, Hist. F. W. Alg., contains no feature that dis-

tinguishes the form from the species as above interpreted, the expression "fasciculi ovate or broadly lanceolate" indicates an identification with *D. acuta.* The large diameter ($100\,\mu$) is not inconsistent with many of our specimens of both species, though it is greater than that reported by European authors.

4. **Draparnaldia platyzonata** sp. nov.

Filaments 1–7 cm. long, loosely tufted or solitary; branches mostly opposite or whorled and horizontal; fascicles of branchlets set strictly perpendicular to the branch, prominently stalked, broadly orbicular in outline, the branchlets somewhat symmetrically radiating from the summits of the branches of the rachis, sometimes densely crowded, subfusiform, acuminate or setiferous; cells of larger branches cylindrical, sometimes slightly constricted at the joints, 50–90 μ in diameter, in length equal to the diameter, or frequently shorter, chromatophore very wide, always nearly covering the length of the cell and often strongly reticular; diameter of terminal branchlets 6–11 μ (*pl. 41*).

On rocks or sticks, in brooks draining swamps.

NEW JERSEY: Grantwood, April, 1899 (89), April, 1900 (281), May, 1900 (363, type).

VERMONT: Fifield bog, Wallingford, 2 July, 1901 (641).

This species in certain stages recalls the figure of *D. plumosa opposita* Lyngbye, Tent. Hyd. Dan. *pl. 65A*, and resembles the specimens of *D. glomerata biformis* Wittrock and Nordstedt, Alg. Exsic. *513*. It lacks, however, what seem to be essential characters of these two forms, namely, the two longitudinal lines supplying the place of a chlorophyll band in the former, and the double character of the filament which gives the name to the latter. Our form is always easily recognizable by its short cylindrical cells with their broad chromatophore, and by the horizontally set, rosette-like, stout-stalked fascicles of branchlets. Though the chromatophore of *D. glomerata* and *D. plumosa* is sometimes described as a reticular band, it might better be called perforate, while that of *D. platyzonata* attains the maximum of a truly reticular structure. This species is more distinct from *D. glomerata* than the members of the *D. plumosa-acuta-glomerata* series are from one another. This view has been confirmed by repeated collections from the type station and by cultures of that material.

During the first week of April, 1901, a visit to the station was made to get material for distribution, but owing to the lateness of the season no *Draparnaldia* had appeared. Before a second visit in May, the encroachments of civilization had so disturbed the brook that no vegetation remained, and it is to be feared that the station is permanently lost.

It was, therefore, particularly pleasing to stumble upon this species during a field meeting of the Vermont Botanical Club in July. The reason for finding this species still vigorous after an extremely hot period, is probably that, in the Vermont bog, it was growing at an altitude of two to three thousand feet.

DOUBTFUL OR LITTLE KNOWN SPECIES

DRAPARNALDIA BILLINGSII Wood, Proc. Am. Phil. Soc. **11**: 143. 1869; Hist. F. W. Alg. 208. *pl. 14. f. 6.* 1873. DeToni, Syll. Alg. **1**: 191. 1889.

There is nothing in Wood's description which marks this species as especially different from the common forms. Possibly it is to be identified with *D. acuta.* A fragmentary specimen bearing the name was seen in the Wolle herbarium. Chodat disposes of this species and *D. cruciata* Hicks as forms of *D. plumosa* without giving evidence of more knowledge of their character than may be gained from the unsatisfactory published descriptions.

DRAPARNALDIA OPPOSITA (Lyngb.) Agardh, Syst. Alg. 59. 1824. Kütz. Spec. Alg. 357. 1849 (*sub Species inquirendae*). Harvey, Ner. Bor. Am. **3**: 71. 1857. DeToni, Syll. Alg. **1**: 194. 1889.

D. plumosa opposita Lyngbye, Tent. Hyd. Dan. 190. *pl. 65A.* 1819.

It is very doubtful whether the form reported by Harvey was correctly named; his description reads very much as though he had a form of *D. plumosa.* Both the description* and figure given by Lyngbye indicate a form very similar to our *D. platyzonata.*

The specimen issued by Miss Tilden as *D. opposita* (Am. Alg. *12*) was doubtless identified by the description of Harvey or of

* "Ramis inferioribus subverticillatis; penicillis brevibus, patentibus, oppositis; articulis diametro subaequalibus, lineis linis longitudinalibus notatis."

DeToni; it is inconceivable that this slender, erect-branched form should have been so identified by any one familiar with Lyngbye's work.

Agardh quotes in the synonymy of this species, *Batrachospermum Americanum* Schweinitz. This was in all probability merely a manuscript name, but a specimen bearing this name in Schweinitz's hand in the Torrey herbarium is not *Draparnaldia* but *Chaetophora incrassata;* it was so recognized by Bailey, who called it *Chaetophora Schweinitzii* (*cf.* Kütz. Tab. Phyc. **3**: 6. 1853).

DRAPARNALDIA SPINOSA Kütz. Phyc. Germ. 230. 1845; Spec. Alg. 356. 1849; Tab. Phyc. **3**: *pl. 13. f. 1.* 1853. Wolle, Bull. Torrey Club, **8**: 40. 1881; F. W. Alg. 109. *pl. 93. f. 1–8.* 1887.

Wolle's figures appear to represent a plant different from any known to us. Whether his specimens were correctly determined can probably be decided only by a visit to his station, Glen Onoko, Pa. No specimens bearing this name were seen in the Wolle herbarium.

DRAPARNALDIA RAVENELII Wolle, F. W. Alg. 110. *pl. 95.* 1887. DeToni, Syll. Alg. **1**: 193. 1889.

Batrachospermum vagum Ravenelii Wolle, Bull. Torrey Club, **9**: 29. 1882.

This species seems to possess strongly marked characters in the large diameter (150–170 μ) of the filaments and the crowded sessile fascicles of branchlets. We have found no report to show that it has been collected since the type specimens were obtained by H. W. Ravenel in South Carolina. It is strange, but rather in keeping with Mr. Wolle's methods, that in describing this species as *Draparnaldia*, no reference was made to the earlier disposition of it as *Batrachospermum*.

V. EPICLADIA Reinke, Alg. West. Ostsee, 86. 1889; Atlas Deutsch. Meeresalg. 31. 1889*

Thallus microscopic, creeping on the surface of its bryozoan host, irregularly branched on all sides, often appearing to be composed of a small central plate of cells extended into a fringe of

* This genus was announced without diagnosis in Ber. Deutsch. bot. Gesell. **6**: 241. 1888, and De Toni, Syll. Alg. **1**: 151. 1889.

branched filaments. Chromatophore a homogeneous parietal layer inclosing a pyrenoid.

Reproduction by means of zoöspores (gametes?) of which many be formed in a cell and escape through a round hole in the cell-well.

Type (and only species) *E. flustrae* Reinke. Inhabitant of salt water. [Etym. ἐπί, upon, and κλάδος, branch.]

This genus is closely related to *Endoderma*, from which it differs in its non-endophytic habit and in its greater tendency toward the formation of an expanded thallus. Here the plate of cells is central and in some sense primary, while in *Endoderma* it is only accidental, that is, resulting from the coalescence of vigorously growing filaments. *Epicladia* thus seems to furnish a point of connection with the genus *Monostroma* in the Ulvaceae.

1. EPICLADIA FLUSTRAE Reinke, *l. c.*

Cells of the central plate irregularly polygonal in outline, 7–12 μ in diameter [12–20 μ, Reinke], those of the free filaments short-cylindrical or irregular, 5–10 μ in diameter (*pl. 42, f. 2*).

EXSIC.: Phyc. Bor. Am, *160*, Spectacle Island, Penobscot Bay, Maine, July, 1893 (F. S. Collins).

Growing on *Flustra*, *Sertularia*, and other bryozoa, often among the masses of *Fucus* between tide marks.

NEW HAMPSHIRE: Hampton, July, 1884 (F. S. Collins).

MASSACHUSETTS: Nahant, July (451); April, 1892 (F. S. Collins).

NEW YORK: Pelham Bay, May (408, 582).

We have been unable to find this plant in New York waters in summer and autumn.

VI. ENDODERMA Lagerheim, Öfvers. Vet. Akad. Förhand. **1883**²: 74, 75. 1883. Huber, Ann. Sci. Nat. Bot. VII. **16**: 313–326. *pl. 14, 15.* 1892.

Entocladia Reinke, Bot. Zeitung, **37**: 476–478. *pl. 6.* 1879. Not *Endocladia* J. Ag. Linnaea, **15**: 449. 1841.

Reinkia Borzi. Notarisia, **3**: 448. 1888 [*nomen nudum*].

Periplegmatium Hansg. Flora, **72**: 58, 59. 1889. Not Kütz. Phyc. Gen. 273. *pl. 7. f. 3.* 1845.

Thallus microscopic, growing within the membrane of other algae, irregularly branched. Cell-division is mostly confined to the pointed end cells. Chromatophore a sheet covering most of the cell-wall, inclosing a pyrenoid.

Four to eight zoöspores may be formed in any cell and escape by a round hole through the cell-wall and host plant; they lack a red eye-spot, the number of cilia and manner of germination is unknown.

Inhabitants of salt water, for the most part. Type, *E. viridis* (Reinke) Lagerh. [Etym. ἔνδον, within, and δέρμα, cuticle.]

Hansgirg ('89), believing that the type species *Endoderma viridis* was identical with *Periplegmatium ceramii* Kütz., transferred the several species of *Endoderma* to *Periplegmatium*. Kützing's type, besides having, so far as can be judged from his published figures, a different type of branching from that seen in *Endoderma viridis*, is described as epiphytic on Florideae while *Endoderma* is endophytic.

Hansgirg's attempt does not seem to have been taken very seriously, and reliance has been placed in the judgment of Professor Wille ('90) that *Endoderma* is to be retained.

1. ENDODERMA WITTROCKII (Wille) Lagerheim, Öfvers. Vet. Akad. Förhand. **1883**^{2}: 75. 1883. DeToni, Syll. Alg. **1**: 209. 1889. Wille; Engler & Prantl, Nat. Pflanzenfam. **1**^{2}: 94. *f. 57*. 1890.

Entocladia Wittrockii Wille, Förhand. Vidensk. Selskab. Christ. **1880**^{4}: 1–4. *pl.* 1880; Jahrb. wiss. Bot. **18**: 435–437. *pl. 16. f. 12–14*. 1887. Hauck; Rabenh. Krypt. Flor. Deutsch. **2**: 463. *f. 199*. 1885. Collins, Bull. Torrey Club, **18**: 340. 1891.

Periplegmatium Wittrockii Hansg. Flora, **72**: 59. 1889; Phys. und Phyc. Untersuch. 240. 1893. Möbius, Notarisia, **6**: 1291. 1891.

Plant a simple or irregularly branched filament, tapering at the ends, sometimes forming a small single-layered plate by reason of the partial coalescence of the branches; cells 5–10 μ in diameter, and 7–12 μ long (*pl. 42, f. 1*).

EXSIC.: Phyc. Bor. Am. *265*, Nahant, Mass. June, 1893 (F. S. Collins). Endophytic between the layers of the cell-wall of *Elachista fucicola*.

MASSACHUSETTS: Nahant, July (452).

CONNECTICUT: Madison, July, August (453).

VII. BOLBOCOLEON Pringsheim, Phys. Abhand. Königl. Akad. Wiss. **1862**: 8. *pl. 1.* 1863. Huber, Ann. Sci. Nat. Bot. VII. **16**: 308–311. *pl. 13. f. 8–12.* 1892.

Thallus microscopic, epiphytic, consisting of a more or less branched creeping filament of irregularly shaped cells on which are borne smaller bulb-shaped cells (representing branchlets), the latter produced at the summit into a tube from which grows a long flagelliform hair. Chromatophore, in the larger cells, a parietal sieve-like layer containing 5–10 pyrenoids; in the smaller piliferous cells, an irregularly toothed plate with two pyrenoids.

Asexual (?) reproduction by means of biciliate zoöspores, produced in large numbers in the vegetative cells.

Type (and only species) *B. piliferum* Pringsh. Inhabitant of salt water. [Etym. *βολβός*, a bulb, and *κολεόν*, sheath.]

1. BOLBOCOLEON PILIFERUM Pringsheim, *l. c.* Farlow, Marine Algae, 57. 1881. Hauck; Rabenh. Krypt. Flor. Deutsch. **2**: 465. *f. 201.* 1885. Reinbold, Schrift. Naturw. Ver. Schles.-Holst. **8**: 138. 1889. DeToni, Syll. Alg. **1**: 211. 1889. Huber, *l. c.* Wille; Engler & Prantl, Nat. Pflanzenfam. **1²**: 96. *f. 60.* 1890.

Vegetative cells 12–16 μ thick, subcylindrical and 2–3 times as long as the diameter, or somewhat conical.

Epiphytic among the cortical cells of *Leathesia tuberiformis*, *Chordaria divaricata*, etc., in summer.

NEWFOUNDLAND: Grand Bay, near channel, on *Castagnea virescens*, 1 August 1901 (M. A. Howe).

MAINE: Cape Rosier, on *Ralfsia Borneti*, July, 1900 (F. S. Collins).

MASSACHUSETTS: Swampscott, on *Ralfsia Borneti*, 2 April 1891 (F. S. Collins); Nahant, on *Castagnea virescens*, 12 July 1884 (F. S. Collins); "Woods Holl, Gloucester" (W. G. Farlow).

RHODE ISLAND: Newport, on *Castagnea virescens*, 18 June 1883 (F. S. Collins).

CALIFORNIA: San Pedro Bay, on *Nemalion Andersonii*, November, 1898 (Miss S. P. Monks).

There is no apparent reason why this species should not be found in Long Island Sound and New York Bay, but careful search in these places has been fruitless.

VIII. CHAETOSPHAERIDIUM Klebahn, Jahrb. wiss. Bot. **24**: 276. 1892; **25**: 306. 1893*

Thallus microscopic, epiphytic on filamentous algae; cells joined in a short filament by means of empty cylindrical utricles, or in a loose aggregation held together by a gelatinous investment. Cells flask-shaped, composed of a globose basal portion produced into a narrow cylindrical or conical summit which forms a basal sheath for a very long and delicate, flagelliform, persistent seta. Chromatophore a parietal layer, carrying a pyrenoid. Division of the cells horizontal, the lower of the daughter-cells migrating to the side.

Reproduction by means of zoöspores, formed to the number of 4 or more (?) in any cell.

Inhabitants of fresh water. Type *C. Pringsheimii* Klebahn. [Etym. χαίτη, hair, and σφαιρίδιον, a little sphere.]

1. CHAETOSPHAERIDIUM PRINGSHEIMII Klebahn, Jahrb. wiss. Bot. **24**: 276. *pl. 4.* 1892; **25**: 307. *pl. 14. f. 11.* 1893. Moebiüs, Flora, **75**: 433. 1892. De Wild. Flor. Buitenz. **3**: 60. 1900.

Aphanochaete globosa Moebius, Biol. Centralb. **12**: 105. *f. 8.* 1892.

Thallus composed of 3–18 cells loosely joined into filaments, or with the connecting utricles well developed; cells at the base globose, 9–12 μ in diameter; sheath 1.5–2 μ in diameter, 10–12 μ long (13–18 μ, Klebahn); seta flagelliform, often 200–300 μ long (*pl. 42, f. 3, 4*).

Creeping on *Oedogonium*, Greenwood Lake, New Jersey, September (467).

In the general character of the cells our specimens agree very closely with Klebahn's description. The utricles, mentioned by this author as a prominent character are hardly distinguishable, so that possibly our specimens should be considered his forma *conferta*. In one case only there appeared to be an investment of mucus (shown in our figure). The divergences from *C. Pringsheimii* do not seem sufficient to warrant establishing a new species.

2. CHAETOSPHAERIDIUM GLOBOSUM (Nordst.) Klebahn, Jahrb. wiss. Bot. **25**: 306. *pl. 14. f. 5–10.* 1893; Bot. Centralb. **56**: 323–326. 1893.

Herposteiron globosa Nordst. Alg. ex Ins. Sandvic. 23. *pl. 2. f. 22, 23.* 1878.

* Reported in advanced of publication, Ber. Deutsch. bot. Gesell. **9**: (7). 1891.

Aphanochaete globosa Wolle, F. W. Alg. 119. *pl.* 105. *f.* 5. 1887. Nordst. Svensk. Vet. Akad. Hand. **22**[8]: 15. 1888. Hansg. Flora, **71**: 216. 1888. DeToni, Syll. Alg. **1**: 180. 1889. Saunders, Flora of Neb. **1**: 63. *pl.* 17. *f.* 2. 1894.

Not *Nordstedtia globosa* Borzi, Nuova Notarisia, **3**: 50. 1892.

Cells 14–16 μ in diameter (12–18 μ Klebahn), loosely associated, inclosed in a subglobose gelatinous mass 1 mm. or more in diameter.

"MASSACHUSETTS: Lake Quinsigamond" (G. E. Stone).

"NEW JERSEY: Hammonton" (F. Wolle).

"NEBRASKA: Cherry county" (De Alton Saunders).

We have seen no specimen of this species, but the descriptions of Wolle and Saunders leave little room for doubt that they actually collected it.

The genus *Nordstedtia* Borzi was supposedly founded on *Aphanochaete globosa* (Nordst.) Wolle, but Dr. Klebahn found by comparison of original specimens of Nordstedt's species with drawings of *Nordstedtia* furnished by Borzi, that the latter represented an entirely different plant.

IX. HERPOSTEIRON Nägeli; Kütz. Spec. Alg. 424. 1849

Aphanochaete A. Braun, Betracht. über Erschein. Verjung. 196. 1851. Huber, Ann. Sci. Nat. Bot. VII. **16**: 278–290. 1892.

Thallus microscopic, composed of simple or irregularly branched, creeping filaments. Cells bearing on the dorsal or exposed surface one or more elongated, hyaline, inarticulate bristles, which are inflated or bulb-like at the base but not sheathed. Chromatophore covering the cell-wall more or less completely, inclosing one or more pyrenoids.

Asexual reproduction by means of 4-ciliate zoöspores generally furnished with a red eye-spot, 1–4 produced in a cell.

Sexual reproduction by conjugation of a large female, and much smaller male gamete, both 4-ciliate.

Inhabitants of fresh water. Type, *H. confervicola* Näg. [Etym. ἕρπω, to creep, and στεῖρος, rigid.]

The researches of Huber and Klebahn leave no room for doubt that the two types, *Herposteiron confervicola* Näg. and *Aphanochaete repens* A. Braun, are the same plant. These two investigators, however, reject the earlier name proposed by Nägeli,

on the ground that his description is incomplete and even inaccurate in certain respects. The identification of his plant with that later described by Braun as *Aphanochaete repens* rests upon authentic drawings by Nägeli, but as these were not published with the description, the evidence furnished by them on a matter of priority is not admitted by Klebahn and Huber. From an American point of view, these original drawings, even though unpublished, furnish as valid evidence in regard to the character of Nägeli's species as would be furnished by specimens from his herbarium.

Furthermore, on the very ground upon which it is alleged that Nägeli's genus should be abandoned, there is even more reason for rejecting *Aphanochaete* A. Braun. For in two important points, namely, the description of the bristles as articulate and the zoöspores as biciliate, Braun's characterization is faulty. These inaccuracies gave rise to the confusing and untenable arrangement by Hansgirg ('88, '93) (which was unfortunately adopted by DeToni and by Wille in Engler & Prantl) of the two genera, *Herposteiron* (Näg.) Hansg. (*Aphanochaete* A. Br. *non* Berthold) and *Aphanochaete* (Berthold) Hansg. *non* A. Br.

The identity of the types of these two so-called genera is sufficiently evident by a comparison of Nägeli's drawings, published by Huber, and Berthold's well-known figures.

There is, then, no good reason why the name *Herposteiron confervicola* Näg. should not be retained.

1. HERPOSTEIRON CONFERVICOLA Nägeli; Kütz. Spec. Alg. 424. 1849. Hansg. Flora, **71**: 216. 1888; Phys. und Phyc. Untersuch. 243. 1889. Kirchn. Mik. Pflanz. 11. *pl. 2. f. 23.* 1891. Huber, Ann. Sci. Nat. Bot. VII. **16**: 286. *pl. 9. f. 6, 7.* 1892 [fig. "aprés Nägeli"]. Saunders, Flora of Neb. **1**: 63. *pl. 22. f. 1.* 1894. Möbius, Abhand. Senckenb. Nat. Gesell. **18**: 322. *pl. 2. f. 1.* 1894.

Aphanochaete repens A. Br. Betracht. ü. Erschein. Verjung. 196. 1851. Rabenh. Flor. Eur. Alg. **3**: 391. *f. 114.* 1868. Wood, Hist. F. W. Alg. 212. *pl. 14. f. 5.* 1873. Berthold, Nov. Act. Acad. Leop. Car. **40**: 214. *pl. 18. f. 2–5.* 1878. Kirchn. Krypt. Flor. Schles. **2**[1]: 71. 1878. Cooke, Brit. F. W. Alg. 197. *pl. 80.*

f. 3. 1883. Wolle, F. W. Alg. 119. *pl. 105. f. 8.* 1887. Wille; Eng. & Prantl, Nat. Pflanz. **1**^{2}: 95. *f. 58.* 1890. Klebahn, Jahrb. wiss. Bot. **25**: 294. *pl. 14. f. 1–4.* 1893. Huber, Bull. Soc. Bot. France, **41**: XCIV–CIII. *pl. 7.* 1894. Klebs, Fortpflanz. Alg. und Pilz. 404. *pl. 3. f. 19–22.* 1896. Chodat, Beitr. Krypt. Flor. Schweiz, **1**^{3}: 324–329. *f. 240–243.* 1902.

Aphanochaete confervicola Rabenh. Flor. Eur. Alg. **3**: 391. 1868.

Herposteiron repens Wittr. Bih. Svensk. Vet. Akad. Hand. **1**^{1}: 27. 1872.

Herposteiron Braunii Huber, ex Näg. MS. Ann. Sci. Nat. Bot. *l. c.* De Wild. Flor. Alg. Belg. 38. 1896.

Cells subglobose to nearly cylindrical; setae usually solitary, 3–4 μ thick at the base, very slender above, often 160 μ long, frequently absent or disappearing early (*pl. 42, f. 5–7*).

EXSIC.: Tild. Am. Alg. *133*, St. Paul, Minn., May, 1896. Phyc. Bor. Am. *762*, Wright's Pond, Middlesex Fells, Mass., 19 August 1900 (F. S. Collins).

Epiphytic on various confervae, especially *Oedogonium*, usually in quiet waters.

VERMONT: St. Johnsbury, July (688), October (648, 650), November (668).

MASSACHUSETTS: Middlesex Fells, Wright's Pond, 11 July 1900 (448); Peabody, 24 September 1890 (F. S. Collins).

NEW YORK: Van Cortlandt Park, May (424).

NEW JERSEY: Greenwood Lake, Setember (467).

DOUBTFUL FORM

APHANOCHAETE VERMICULOIDES Wolle, F. W. Alg. 119. *pl. 105. f. 9, 10.* 1887. De Toni, Syll. Alg. **1**: 180. 1889.

EXSIC.: Phyc. Bor. Am. *161*, Norwich, Conn. (W. A. Setchell).

Wolle's description and figures of this species do not show its right to be placed in this genus. No specimen could be found in his herbarium, nor does the exsiccata quoted shed light on the character of the form.

SUMMARY

1. In the Ulothricaceae twenty-seven species and two formae are recognized; of these, three species and one forma are new to

science, one variety is raised to specific rank, and five species are definitely reported in America for the first time. Fourteen species and varieties previously recorded have been considered doubtful, either in respect to their occurrence in this country or their validity in general. Numerous other varieties listed by Wolle, but without record of actual occurrence here have been ignored.

2. In the Chaetophoraceae twenty-nine species and two varieties are recognized: of these, seven species and one variety are described as new, and, in addition, four species and one variety are reported from America for the first time. Fourteen species have been placed on the list of little known or doubtful forms.

3. While records of extended distribution have not been obtained, certain regions, particularly the vicinity of New York city, the palisade region of New Jersey, and, to a lesser degree, portions of New England, regarding which previous records are very meager, have been rather thoroughly explored.

4. In several genera important additions have been made to the knowledge of reproductive processes.

5. A careful study of generic and specific foundations has been made, and in this regard, these plants have been placed upon a firmer and more satisfactory taxonomic basis. It is believed that the discussion of so many forms as doubtful has in a measure cleared the way for a more complete knowledge of these algae.

6. Two genera, namely *Stichococcus* and *Microthamnion*, have been placed in a position more in accordance with their true affinities than they have held with recent authors.

BIBLIOGRAPHY

Agardh, C. A. Algarum Decades, I–IV. 1812–15.

——— Dispositio Algarum Sueciae. 1812.

——— Synopsis Algarum Scandinaviae. 1817.

——— Systema Algarum. 1824.

——— Icones Algarum Europaearum. 1828–35.

Anderson, O. F. Om Palmella uvaeformis Kg. och hvilsporerna hos *Draparnaldia glomerata* Ag. Bot. Notis. 1888: 86, 87. 1888.

Areschoug, J. E. Observationes Phycologicae. Act. Reg. Soc. Sci. Upsal. III. **6**[1]: No. 2. 1866; **9**[1]: No. 1. 1874.

Bailey, J. W. Notes on the Algae of the United States. Am. Jour. Sci. II. **3**: 80–86, 399–403. 1847.

Batters, A. L. List of the Marine Algae of Berwick-on-Tweed. Trans. Berw. Nat. Club, (35). 1889.

Berkeley, J. M. Gleanings of British Algae. 1833.

Berthold, G. Untersuchungen über die Verzweigung einiger Süsswasseralgen. Nov. Act. Acad. Leop. Carol. **40**: 167–230. *pl. 15–18.* 1878.

Blackman, F. F. The Primitive Algae and the Flagellata. An Account of modern Work bearing on the Evolution of the Algae. Ann. of Bot. **14**: 647–688. 1900.

Bohlin, K. Studien öfver några slägten af alggruppen Confervales Borzi. Bih. Kongl. Svensk. Vet. Akad. Hand. **23**^{3}: No. 3. 1–56. *pl. 1, 2.* 1897.

Bory de Saint Vincent, J. B. Mémoire sur le genre *Draparnaldia* de la famille des Conferves. Ann. Mus. Hist. Nat. **12**: 399–409. *pl. 35.* 1808.

——— Articles, "Conferves." Dict. class. d'hist. nat. **4**: 392. 1824; "Draparnaldia," *ibid.* **5**: 614. 1824.

Borzi, A. Studi Algologici. 1–117. *pl. 1–9.* 1883; 118–378. *pl. 10–31.* 1895.

——— Botrydiopsis nuovo genera di alghe verdi. Boll. Soc. Ital. Microsc. **1**: 62–70. 1889.

——— Stadii anamorfici di alcune alghe verdi. Nuov. Giorn. Bot. Ital. **22**: 403–409. 1890.

——— Noterelle algologiche. Nuov. Notar. **2**: 367–391. 1891.

——— Alghe d'acqua dolce della Papuasia raccolte su cranii umani dissepolti. Nuov. Notar. **3**: 35–53. 1892.

Bosc, C. Description d'une espèce de Conferve, *Conferva incrassata.* Bull. Sci. Soc. Phil. **2**: 145–6. *pl. 11. f. 2, A–C.* 1800.

de Brébisson, A. Description de deux nouveaux Genres d'Algues fluviatiles. Ann. Sci. Nat. Bot. III. **1**: 25–31. *pl. 1, 2.* 1844.

Chodat, R. Algues vertes de la Suisse. Beiträge zur Krypt. Flor. Schweiz. **1**^{3}: 259–329. 1902.

Cienkowski, L. Zur Morphologie der Ulotricheen. Bull. Acad. Imp. Sci. St. Pet. **21**: 529–557. 2 *pls.* 1876.

——— Ueber Palmellen-Zustand bei Stygeoclonium. Bot. Zeitung, **34**: 17–26, 70, 71. *pl. 1.* 1876.

Clendenin, Ida. Observations on the zoöspores of *Chaetophora endiviaefolia.* Asa Gray Bull. **1894**: 13, 14. 1894.

Collins, F. S. Notes on New England Marine Algae, IV. Bull. Torrey Club, **11**: 130. 1884; V. *ibid.* **18**: 335–341. 1891.

——— Notes on Algae, II. Rhodora, **2**: 12. 1900.

——— Lists of New England Plants, V. Marine Algae. Rhodora, **2**: 43–45. 1900.

Cornu, M. De la fecondation chez les algues et en particulier chez l'Ulothrix seriata. Bull. Soc. Bot. France, **21**: 72–77. 1874.

Cooke, M. C. Some Fresh Water Algae. Grevillea, **11**: 75. 1882.

——— British Fresh Water Algae, 178–197. 1883.

Crouan, P. L. & H. M. Florule du Finistère. 1867.

DeCandolle, C. Extrâit d'un rapport sur les Conferves. Bull. Sci. Soc. Phil. **3**: 17–21. *pl. 1.* 1801.

DeCandolle, A. P. & Lamarck, J. B. de. Flore Française, **2**: 57–59. 1815. [3rd Ed.]

Derbes, A. & Solier, A. J. J. Sur les organes reproducteurs des Algues. Ann. Sci. Nat. Bot. III. **14**: 261–282. *pl. 32–37.* 1850.

——— Mémoire sur quelques points de la physiologie des Algues. 1856.

DeToni, G. B. & Levi, D. Intorno ad una Palmellacea nuova per la Flore Veneta. Notarisia, **2**: 281–283. 1887.

——— Flora algologia di Venezia, Pt. 3. 1888.

DeToni, G. B. Sylloge Algarum omnium hucusque cognitarum. Vol. 1. 1889.

Desvaux, N. A. Plantes trouvées dans la Haut-Poitou, les unes nouvelles, les antres, point indiquées dans la Flore de France. Journ. de Bot. **2**: 307. 1809.

Dillenius, J. J. Historia Muscorum, 12–14. *pl. 2.* 1741.

Dillwyn, L. W. British Confervae, or Colored Figures and Descriptions of the British Plants referred by botanists to the Genus *Conferva.* 1802–1809.

Dodel-Port, A. Ulothrix zonata, ihre geschlechtliche Fortpflanzung, ein Beitrag zur Kentniss der unteren Grenze des pflanzenlichen Sexualbebens. Jahrb. wiss. Bot. **10**: 417–550. *pl. 31–38.* 1876.

——— Illustrirtes Pflanzenleben, 148, 149. 1883.

Farlow, W. G. Marine Algae of New England. 1881.

Fries, E. M. Systema Orbis Vegetabilis. Plantae Homonemeae, 345. 1825.

——— Stirpium Agri Femsionensis Index, 44. 1825–6.

——— Flora Scanica, 324–329. 1835.

Gay, F. Sur la formation des kystes chez les Chlorosporées. Bull. Soc. Bot. France, **33**: LI–LX. 1886.

——— Sur les *Ulothrix aeriens*. Bull. Soc. Bot. France, **35**: 65–75. 1888.

——— Sur le développement et la classification de quelques Algues vertes. 1891.

——— Sur quelques algues de la Flore de Montpellier. Bull. Soc. Bot. France, **40**: CLXXIII–CLXXVIII. 1893.

Gray, S. F. A Natural Arrangement of British Plants. **1**: 301–316. 1821.

Hansgirg, A. Prodromus der Algenflora von Böhmen. Arch. Nat. Land. Böhm. **6**[6]: 1886–88; **8**[4]: 1893.

——— Physiologische und Algologische Studien. *4 pl.* 1887.

——— Ueber die Gattungen *Herposteiron* Näg. und *Aphanochaete* Berth. non A. Br. nebst einer systematischen Uebersicht aller bisher bekannten Confervoiden-Gattungen. Flora, **71**: 212–223. 1888.

——— Ueber die aerophytischen Arten der Gattungen *Hormidium* Ktz., *Schizogonium* Ktz. und *Hormiscia* Aresch. (*Ulothrix* Ktz.). Flora, **71**: 259–266. 1888.

——— Beitrag zur Kentniss der Algengattungen *Entocladia* Reinke (*Entoderma* Lagerh., *Periblegmatium* Ktz.) und *Pilinia* Ktz. (*Acroblaste* Reinsch). Flora, **71**: 499–504. *pl. 12*. 1888.

——— Resultate der vom Verfasser im Jahre 1888 ausgeführten Durchforschung der Süsswasseralgen * * * Böhmens. Sitz.-ber. K. Böhm. Gesell. Wiss. **1889**[1]: 124–164. 1889.

——— Ueber die Gattungen *Crenacantha* Ktz., *Periplegmatium* Ktz., und *Hansgirgia* DeToni. Flora, **72**: 56–59. 1889.

——— Nachträge zu meiner Abhandlung "Ueber die aerophytischen Arten der Gattung *Hormidium* * * *" nebst Bemerkungen über F. Gay's "Recherches sur * * * quelques algues vertes." Bot. Centralb. **47**: 6–9. 1891.

——— Algologische und bacteriologische Mittheilungen. Sitz.-ber. K. Böhm. Gesell. Wiss. **1891**: 297–365. 1891.

Hansgirg, A. *Chaetosphaeridium* Pringsheimii Klebahn ist mit *Aphanochaete globosa* (Nordst.) Wolle identisch. Oester. Bot. Zeitschr. **42**: 366, 367. 1892.

——— Noch einmal über *Chaetosphaeridium Pringsheimii* Kleb. und *Aphanochaete globosa* (Nordst.) Wolle. Oester. Bot. Zeitschr. **43**: 56, 57. 1893.

——— Mein letztes Wort über *Chaetosphaeridium Pringsheimii* Kleb. und *Aphanochaete globosa* (Nordst.) Wolle. Bot. Centralb. **56**: 321–323. 1893.

——— Physiologische und phycologische Untersuchungen. 1893.

Harvey, W. H. Manual of the British Algae, 121–132. 1841.

——— Manual of the British Marine Algae, 209–227. 1849.

——— Phycologia Britannica, **4**: 1846–51.

——— Nereis Boreali-americana, **3**: 69–72, 89, 90. 1858.

Hassall, A. H. Observations on the Growth, Reproduction and Species of the Branched Freshwater Confervae. Ann. & Mag. Nat. Hist. **11**: 359–364. May, 1843.

——— Descriptions of British Freshwater Confervae, mostly new, with Observations on some of the Genera. Ann. & Mag. Nat. Hist. **11**: 428–437. June, 1843.

——— History of the British Freshwater Algae. 1845.

Hauck, F. Die Meeresalgen Deutschlands und Oesterreichs. Rabenhorst's Kryptogamen Flora von Deutschland, Oesterreich und der Schweiz, **2**: 440–443, 462–466. 1885.

Hedwig, R. A. *Tremella Nostoch.* 1798.

Hooker, W. J. Flora Scotica, **2**: 76–83. 1821.

——— British Flora, **2**[1]: 350–354, 388–390. 1833.

Huber, J. Observations sur la valeur morphologique et histologique des poils et des soies dans les Chaetophorées. Jour. de Bot. **6**: 321–341. 1892.

——— Contributions à la connaisance des Chaetophorées épiphytes et endophytes et du leurs affinités. Ann. Sci. Nat. VII. **16**: 265–359. *pl. 8–18.* 1892.

——— Sur *l'Aphanochaete repens* A. Br. et sa reproduction sexuée. Bull. Soc. Bot. France, **41**: XCIV–CIII. *pl. 7.* 1894.

Hudson, W. Flora Anglica, 572. 1778. [2d ed.]

Itzigsohn, H. Ueber die Sporenbildung der Chaetophoreen. Bot. Zeitung, **10**: 785–787. 1852.

——— Ueber die Algengattung *Psichohormium*. Flora, **37**: 16–20. *pl. 1*. 1854.

Kickx, J. Flore Cryptogamique des Flandres, **2**: 417–421. 1867.

Kirchner, O. Algen. Cohn's Kryptogamen-Flora von Schlesien, 2^1: 67–80. 1878.

——— Die Mikroskopische Pflanzenwelt des Süsswassers, 10–12. 1891. [2d ed.]

Kjellman, F. R. Om Spetsbergens marine, klorofyllförande Thallophyter. II. Bih. Svensk. Vet. Akad. Hand. 4^6: 1–61. 1877.

——— Norra Ishafvets Algflora, 385–387. 1883.

——— Algae of the Arctic Sea. Kongl. Svensk. Vet. Akad. Hand. 20^5: 285, 314–316 1883.

Klebahn, H. *Chaetosphaeridium Pringsheimii*, novum genus et nova species algarum chlorophycearum aquae dulcis. Jahrb. wiss. Bot. **24**: 268–282. *pl. 4*. 1892.

——— Zur Kritik einiger Algengattungen. Jahrb. wiss. Bot. **25**: 278–321. *pl. 14*. 1893.

——— Zur Abwehr der Vorwürfe und Behauptungen des Herrn Professor Hansgirg in Prag. Bot. Centralb. **56**: 323–326. 1893.

Klercker, J. af. Ueber Zwei Wasserformen von *Stichococcus*. Flora, **82**: 90–106. *pl. 6*. 1896.

Klebs, G. Die Bedingungen der Fortpflanzung bei einiger Algen und Pilzen, 300–423. 1896.

Kützing, F. T. Algologische Mittheilungen. II. Ueber eine neue Gattung der Confervaceen [*Ulothrix*]. Flora, **16**: 517–521. 1833.

——— Algarum aquae dulcis Germanicarum, Decades I–XVI. 1833–36. (Flora, **16**: 692–701. 1833; **17**: 710–719. 1834; **19**: Intell.-blatt. **1**: 16. 1836.)

——— Ueber die Systematische Eintheilung der Algen. Linnaea, **17**: 75–107. 1843.

——— Phycologia Generalis. 1843.

——— Phycologia Germanica. 1845.

——— Diagnosen und Bemerkungen zu neuen oder Kritischen Algen. Bot. Zeitung, **5**: 177. 1847.

——— Species Algarum. 1849.

——— Tabulae Phycologicae oder Abbildungen der Tange, **2**, **3**. 1852–3.

Lagerheim, G. Bidrag till Sveriges Algflora. Öfvers. Vet. Akad. Förhand. **1883**[2]: 74, 75. 1883.

——— Zur Entwickelungsgeschichte Einiger Confervaceen. Ber. Deutsch. bot. Gesell. **5**: 409–417. 1887.

——— Ueber eine durch die Einwirkung von Pilzhyphen entstandene Varietät von *Stichococcus bacillaris* Näg. Flora, **71**: 61–63. 1888.

——— Studien über die Gattungen *Conferva* und *Microspora*. Flora, **72**: 179–210. *pl. 5, 6.* 1889.

Le Jolis, A. Liste des Algues Marines de Cherbourg. Mém. Soc. Imp. Sci. Nat. Cherb. **10**: — (57, 58). 1864. [Only the reprint of 1880 has been seen.]

Link, H. F. Epistola de Algis aquaticis in Genera disponendis. Horae physicae Berolinensis curavit Dr. C. G. Nees ab Esenbeck. 1820. (Flora, **4**: 509–513. 1821.)

Linnaeus, C. Genera Plantarum, 326. 1737.

——— Species Plantarum, 1164. 1753.

Lyngbye, H. C. Tentamen Hydrophytologiae Danicae. 1819.

Martius, K. F. P. Flora cryptogamica Erlangensis. 1817.

Maupas, E. Sur la position systematique des Volvocinées et sur les limites des règne végétal et du règne animal. Comptes rendus Acad. Sci. **88**: 1274–77. 1879.

Möbius, M. Conspectus algarum endophytarum. Notarisia, **6**: 1279–1304. *pl. 14.* 1891.

——— Australische Susswasser Algen. II. Ahand. Senck. Naturf. Gesell. **18**: 309–350. *pl. 1, 2.* 1895.

———Morphologie der haarartigen Organe bei den Algen. Biol. Centralb. **12**: 71–87, 97–108. 1892.

Montagne, J. F. C. Sylloge generum speciumque Cryptogamarum. 1856.

Müller, O. F. Nachricht von einer sonderbaren und seltenen Pflanze. Der Naturforscher, **7**: 189–194. *pl. 3. f. 1–3.* 1775.

——— De Confervis palustribus oculo nudo invisibilibus. Nov. Act. Acad. Sci. Petrop. **3**: 89–98. *pl. 1, 2.* 1788.

Nägeli, C. Gattungen einzelliger Algen, physiologisch und systematisch bearbeiteit. Neue Denkschr. allg. Schweiz. Gesell. fur gesam. Naturwiss. **10**[2]: 76, 77. 1849.

——— Bildung der Schwärmsporen bei *Stigeoclonium insigne* Näg. Pflanzen-physiologische Untersuchen, **1** : 36–42. *pl. 1.* 1855.

Nordstedt, O. De algis aquae dulcis * * *, ex insulis Sandvicensibus, 22, 23. Ex Minnesskrift Fysiografiska Sällskapet. 1878.

——— Fresh-water Algae collected by Dr. S. Berggren in New Zealand and Australia. Kong. Svensk. Vet. Akad. Hand. **22**^{8} : 14–18. 1888.

Pringsheim, N. Ueber die Dauerschwärmer des Wassernetzes. Monatsber. Kön. Akad. Wiss. Berl. **1860** : 775–791. 1861.

——— Beiträge zur Morphologie der Meeres-Algen. Phys. Abhand. Kön. Akad. Wiss. Berl. **1862** : 1–37. *pl. 1–8.* 1863.

Rabenhorst, L. Deutschlands Kryptogamen Flora, **2**^{2} : 87–115. 1847.

——— Kryptogamen-Flora von Sachsen, der Ober-Lausitz, Thüringen und Nordböhmen, **1** : 230–274. 1863.

——— Flora Europaea Algarum, **3** : 290–391. 1868.

Reinbold, T. Die Chlorophyceen (Grüntange) der Kieler Föhrde. Schrift. Naturwiss. Ver. Schles.-Holst. **8** : 109–144. 1889.

Reinke, J. Zwei parasitische Algen. Bot. Zeitung, **37** : 472–478. *pl. 6.* 1879.

——— Algenflora der westlichen Ostsee, deutschen Antheils. 1889.

——— Atlas deutscher Meeresalgen. 1889.

Reinsch, P. Die Algenflora des mittleren Theils von Franken. 1867.

Römer, F. A. Die Algen Deutschlands. 1845.

Rosenvinge, J. L. A. K. Bidrag til kundskaben om slagterne *Ulothrix* og *Conferva*, saerligt med hensyn til vaeggens bygning. Bot. Tids. **11** : 114–134. *pl. 1.* 1879.

——— Grønlands Havalger. Medd. om Grøn. **3**^{3} : 761–981. 1893.

Roth, A. W. Catalecta Botanica. 1797–1806.

——— Novae plantarum species. Römer's Archiv für Bot. **1**^{3} : 37–52. 1798.

——— Tentamen Florae Germanicae, **3** : 1800.

——— Neue Beyträge zur Botanik, **1** : 239 et seq 1802. (Observations on the Rivulariae and the Genera related to them. Ann. of Bot. **1** : 247–283. 1805.) [Only the translation has been seen.]

Saunders, De A. Protophyta-Phycophyta. Flora of Nebraska, **1** : 1–68. 1894.

Schaarschmidt, J. Némely Chlorosporeák vegetativ alakváltozasairól. Mag. Növén. Lap. **7**: 103–113. *pl. 4.* 1883.

Schmidle, W. Beiträge zur Algenflora des Schwarzwaldes und der Rheinebene. Ber. Naturf. Gesell. Freib. **7**: 68–112. *pl. 1–6.* 1893.

——— Beiträge zur Algenflora des Schwarzwaldes und des Oberrheins. Hedwigia, **36**: 1–25. 1897.

——— Einige Algen aus preussischen Hochmooren. Hedwigia, **38**: 156–176. *pl. 6, 7.* 1899.

——— Algologische Notizen. Allg. Bot. Zeitschr. **6**: 234. 1900.

Schmitz, F. Untersuchungen über die Zellkerne der Thallophyten, Sitz.-ber. Niederrhein. Gesell. Bonn, **1879**: 345–376; **1880**: 122–132. 1880.

——— Die Chromatophoren der Algen. Verh. Nat. Ver. preuss. Rheinl. und Westf. **40**: 1–180. *pl. 1, 2.* 1883.

Schrank, F. von P. Botanische Rhapsodien. Der Naturforscher, **19**: 124–126. *pl. 7. f. 2, 3.* 1783.

——— Baiersche Flora, **2**: 490, 491. 1789.

Sorokine, N. Note sur le developpement de l'*Hormidium varium.* Nuov. Giorn. Bot. Ital. **6**: 190–195. *pl. 5.* 1874.

Stone, G. E. Flora of Lake Quinsigamond. Ann. Rep. Worcester Nat. Hist. Soc. 1900

Thuret, G. Recherches sur les zoöspores des Algues. Ann. Sci. Nat. Bot. III. **14**: 214–260. *pl. 16–31.* 1850.

Tilden, J. E. List of Fresh-Water Algae collected in Minnesota during 1894. Minn. Bot. Stud. **1**: 228–237. 1895.

——— A Contribution to the life history of *Pilinia diluta* Wood and *Stigeoclonium flagelliferum* Kg. Minn. Bot. Stud. **1**: 601–635. *pl. 31–35.* 1896.

——— Some new Species of Minnesota Algae which live in a calcareous or siliceous Matrix. Bot. Gaz. **23**: 95–104. *pl. 7–9.* 1897.

——— Observations on some West American thermal Algae. Bot. Gaz. **25**: 89–105. *pl. 8, 9.* 1898.

Trevisan, V. Le Alghe del Tenere Udinese, 16. 1844.

Vaucher, J. P. Memoire sur les graines des Conferves. Bull. Sci. Soc. Phil. **2**: 185–187. *pl. 12.* 1801; Jour. de Phys. **52**: 344–359. *pl. 3, 4.* 1801.

——— Histoire des Conferves d'eau douce. 1803.

Wallroth, F. G. Flora Cryptogamica Germaniae, **2**: 20–40. 1833.

Wilcke, J. C. Om en liten Växt, som växer uti Driks glas, och hålles för en *Sertularia* eller *Conferva*. Kongl. Vet. Akad. Handl. **25**: 264–270. *pl. 8. f. 2–8.* 1764.

de Wildeman, E. Note sur deux espèces terrestres du genre *Ulothrix*. Bull. Soc. Bot. Belg. **25**: 7–18. *pl. 1.* 1886.

——— Sur la formation des Kystes Chez les *Ulothrix*. Bull. Soc. Bot. Belg. **26**^{2}: 49–52. 1887.

——— Le genre *Microspora* Thur. doit-il être conservé? Bull. Soc. Bot. Belg. **26**^{2}: 84–88. 1887.

——— Sur *l'Ulothrix flaccida* Kütz. et le *Stichococcus bacillaris* Näg. Bull. Soc. Bot. Belg. **27**^{2}: 78–85. 1888.

——— Flore des Algues de Belgique. 1896.

——— Les Algues de la Flore de Buitenzorg. Flore de Buitenz. Pt. 3. 1900.

Wille, N. Om en ny endophytisk' Alge. Forhand. Vid.-Selskab. Christ. **1880**^{4}: 1–4. *pl. 1.* 1880.

——— Algologiska Bidrag. I. Om Celledelingen hos *Conferva*. Forhand. Vid.-Selskab. Christ. **1880**^{5}: 1–25. *f. 1–14.* 1880.

——— Om Hvileceller hos *Conferva* (L.) Wille. Öfvers. Kongl. Vet. Akad. Forhand. **1881**^{8}: 3–25. *pl. 9, 10.* 1882.

——— Ueber Akineten und Aplanosporen bei den Algen. Bot. Centralbl. **16**: 215–219. 1883.

——— Alger fra Novaia-Zemlia og Kara-Havet. Dijmphna-Togtets zoöl.-bot. Udbytte, 81–90. *pl. 12. f. 1, 7, 8.* 1885.

——— Algologische Mittheilungen. Jahrb. wiss. Bot. **18**: 425–518. *pl. 16–19.* 1887.

——— New Forms of Green Algae. Rhodora, **1**: 149. 1899.

——— Chlorophyceae. Engler & Prantl, Die natürlichen Pflanzenfamilieen, **1**^{2}: 24–160. 1890.

——— Algologische Notizen, VII. Zur Verbreitung der Susswasseralgen in Südlichen Norwegen. Nyt Mag. for Naturvid. **39**: 1–22. 1901.

——— Studien über Chlorophyceen, I–VII. Vid.-Selsk. Skrift. **1900**^{6}: 1–46. *pl. 2, 3.* 1901.

Wittrock, V. B. Om Gottands och Ölands Sötvattens-alger. Bih. Kong. Svensk. Vet. Akad. Hand. 1^1: 1–72. *pl. 1–4.* 1872.

——— Om Snöns och Isens Flora. Nordenskiöld's Studier och Forskningar. *pl. 3.* 1883.

Wood, H. C. A Contribution to the History of the Fresh-Water Algae of North America. Smithsonian Contributions to Knowledge. 1872.

Description of Plates

The outlines of the drawings were made by means of a Leitz camera lucida and the details filled in by careful reference to the specimens. Three combinations were used, namely, Leitz ocular 3 with objective $\frac{1}{12}$ oil immerson, ocular 3 with objective 7, and ocular 1 with objective 7, and the drawings thus made reduced one half in reproduction, so that the actual magnifications of the figures are 575, 350 and 255 diameters. Most of the drawings were made from preparations made by the Flemming-chromic-alum method. For convenience in identifying the material from which the drawings were made, numbers of collections corresponding to those in the text, and the pages on which the descriptions appear are appended.

PLATE 20 (magnification 575 : 1)

1. *Ulothrix zonata.* Lower rhizoid-like portion of a filament (381), p. 148.

2. Upper portion of the same filament. This specimen corresponds to *U. attentuata* Kütz., but many filaments of the same material have lower cells differing little in diameter from the upper cells, showing that this is an accidental variation.

3. A young filament with longer cells (594).

4. Formation of zoöspores, and evacuated cells; a motile zoöspore (594).

5, 6. *Ulothrix tenuissima.* Portions of two filaments (535); distinguished from small forms of *U. zonata* chiefly by the shortness of the cells, p. 149.

7–9. *Ulothrix flacca.* Apical, middle, and rhizoidal portions of the same filament (533), p. 155.

PLATE 21 (575 : 1)

1, 2. *Ulothrix implexa.* Vegetative filaments (570 A), p. 154.

3, 4. *Ulothrix tenerrima.* Two filaments showing different condition of the chromatophores (645), p. 151.

5–7. *Ulothrix variabilis.* Vegetative filaments (557, 574), p. 152.

8, 9. *Stichococcus marinus.* Contrast chromatophores with those of preceding figures (570 B), p. 161.

10. *Stichococcus subtilis.* Cells evacuated by zoöspores (321), p. 163.

11, 12. Vegetative filaments (427 A, 549).

13. Filament from a drying rock, in which akinetes seem to be forming.

14, 15. *Stichococcus flaccidus.* Zoösporiferous filaments and motile zoöspores (618), p. 164.

16, 17. Vegetative filaments showing varying proportions of the cells (536, 315).

PLATE 22 (575 : 1)

1. *Stichococcus bacillaris.* (637), p. 160.

2, 3. *Stichococcus bacillaris* forma *confervoidea* (550, 534), p. 160.

4–6. *Stichococcus scopulinus.* Showing the variation in the length of the cells, and the coccoid state (531), p. 161.

7–9. *Stichococcus fluitans.* Filaments breaking up, and the coccoid state (575), p. 165.

10–13. *Stichococcu rivularis.* Terminal and intercalary rhizoidal hooks (568), p. 166.

PLATE 23 (575 : 1)

1. *Microspora amoena.* (447 A), p. 170.
2. *Microspora crassior.* (620), p. 169.
3, 4. *Microspora Loefgrenii.* (351, 447 B), p. 171.
5. *Microspora Wittrockii.* (348), p. 172.
6. A filament from the same material, showing the structure of the cell-wall after prolonged preservation in pyroligneous-acid-formol solution.
7. One of the H units of the cell-wall.

PLATE 24 (575 : 1)

1. *Microspora floccosa.* A filament with greater diameter and more inflated cells than usual (349), p. 174.
2. A typical filament in active growth, with somewhat reduced chromatophore (409).
3. A filament containing zoöspores (599).
4. Akinetes and two dead cells (283 A).
5. *Microspora Willeana.* A vegetative filament, with dead cells at top and bottom (609), p. 175.
6. An aplanospore or dead zoöspore, a dead cell, and an akinete (609).
7. End of a filament of akinetes (609).
8, 9. *Microspora tumidula.* Vegetative filaments (600, 679), p. 177.
10. The structure of the cell-walls brought out by prolonged preservation in pyroligneous-formol solution (283 C).
11. Formation of akinetes (573 A).
12. *Microspora stagnorum.* Vegetative filament and zoöspore formation (495) p. 176.
13. A vegetative filament with long cells (66).
14. *Microscopa quadrata.* End of a filament from material which formed a furry coating on sticks in an aquarium (669), p. 178.
15. Filament from a confervoid mass (423).

PLATE 25 (575 : 1)

1, 2. *Tribonema bombycinum.* Varying forms of vegetative cells (430, 421), p. 184.
3. Cells pulling apart for dispersal of zoöspores (128). [This single figure was originally drawn from living material with ocular 3 and objective 7, and later was enlarged to the scale of the rest of the plate.]
4. *Tribonema bombycinum* forma *tenue.* A filament drawn at the time of collection, October 19th (499 A), p. 185.
5. From the same material, drawn October 30th, showing the change in the chromatophores produced by better nutritive conditions.
6. A common form (443 B).
7, 8. *Tribonema minus.* (443 C, 428), p. 186.

9, 10. *Tribonema utriculosum.* Young and mature filaments from a single collection (418), p. 186.

11. A mature vegetative filament (579).

PLATE 26 (575 : 1)

1. *Microthamnion Kuetzingianum.* A plant of moderate size, showing zoöspore formation and cells evacuated by zoöspores (532), p. 191.

2. *Microthamnion strictissimum.* Lower part of a plant of moderate size, corresponding closely to Rabenhorst's type material (524), p. 191.

3, 4. End branches of the same.

5. End branches from a short and slender form (613).

PLATE 27 (575 : 1)

1. *Microthamnion strictissimum macrocystis.* Nearly all of a medium-sized plant (608), p. 192.

2. *Microthamnion Kuetzingianum.* A medium-sized plant (532).

3, 4. Young plants (561 B).

PLATE 28

1. *Myxonema lubricum.* Middle portion of the typical form (638), p. 196 (350 : 1).

2. Setiferous state, upper portion (515 A) (350 : 1).

3, 4. *Myxonema lubricum varians.* Formation of zoöspores (456), p. 198 (575 : 1).

PLATE 29 (350 : 1)

Myxonema amoneum. Fig. 2 joins Fig. 1 at the point marked ×; there was an interval of six cells between Fig. 2 and Fig. 3 (558), p. 199.

PLATE 30 (350 : 1)

Myxonema sububigerum (374), p. 200.

PLATE 31 (350 : 1)

Myxonema ventricosum. The small figure joins the main stem twenty cells below (359), p. 201.

PLATE 32 (350 : 1)

1. *Myxonema tenue.* The main stem, drawn with the diameter slightly too great in comparison with the other figures in this genus (615 B), p. 202.

2. Setiferous state, a branch from near the summit (458).

PLATE 33 (350 : 1)

1, 2. *Myxonema aestivale.* Lower part of a plant; Fig. 2 joins Fig. 1 at the point marked × (463), p. 205.

3. Upper part of another plant (654).

4, 5. *Myxonema lubricum varians.* A portion from the upper part of a plant; the diameter is slightly too small in comparison with that of *M. tenue* (336), p. 198.

PLATE 34 (350 : 1)

Myxonema glomeratum (591), p. 205.

PLATE 35 (350: 1)

1. 2. *Myxonema attenuatum.* Portions of main filaments (540), p. 206.

3. The thickly branched lower portion (547).

PLATE 36 (350: 1)

1, 2. *Myxonema stagnatile* (553), p. 207.

3. *Myxonema subsecundum.* Cell outlines of dried material from Pleasantville, N J., p. 207.

PLATE 37 (350: 1)

1. *Chaetophora elegans.* Part of the basal portion of a colony (602), p. 211.

2. Upper portion of a branch showing the open character of the branching (392).

3. A setiferous terminal fascicle of branchlets (367).

PLATE 38 (350: 1)

1. *Chaetophora pisiformis.* Upper part of the filaments which are very strictly branched throughout (434), p. 212.

2. *Chaetophora incrassata.* A small fascicle of branchlets with some of the main filaments (601), p. 214.

3. A fascicle of branchlets forming akinetes, well supplied with reserve materials (345); cf. *Chaetophora monilifera* Kütz.

PLATE 39 (350: 1)

1. *Chaetophora attenuata.* Upper part of filaments (491), p. 213.

2. Part of the basal portion of a colony (466).

PLATE 40 (255: 1)

1. *Draparnaldia plumosa.* Cells from a main stem; Flemming-haematoxylin preparation (218), p. 218.

2. A small fascicle of branchlets from near the summit of the plant (360).

3. *Draparnaldia glomerata.* A small fascicle of branchlets on cells of the main filament (280), p. 220.

4. Rhizoidal portion of a young plant (545).

PLATE 41 (255: 1)

Draparnaldia platyzonata. The small branch was removed from the nearest node of the main filament (363), p. 222.

PLATE 42 (575: 1)

1. *Endoderma Wittrockii,* in the cell-wall of *Elachista fucicola* (453), p. 226.

2. *Epicladia flustrae.* About half of a thallus (451), p. 225.

3, 4. *Chaetosphaeridium Pringsheimii* (497), p. 228.

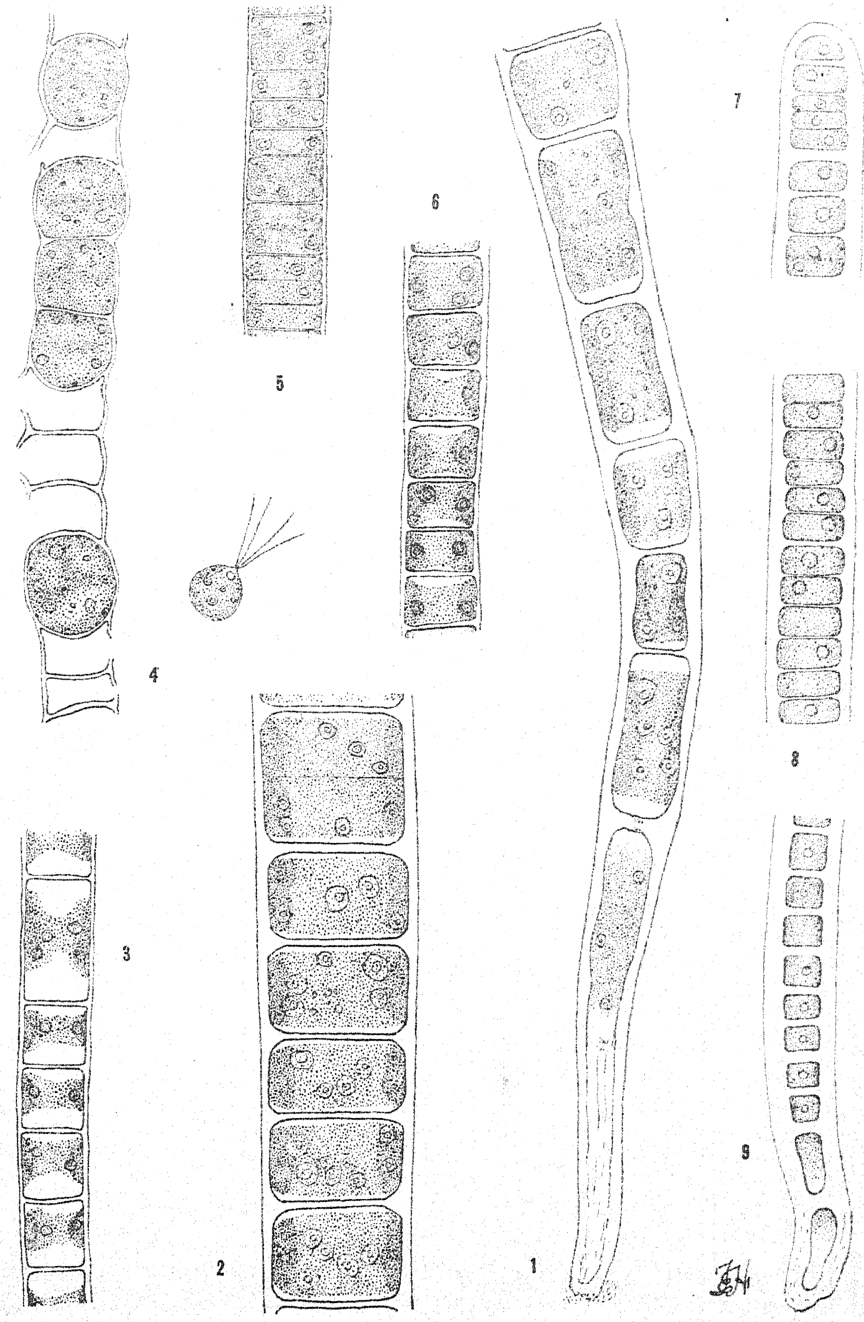
5. *Herposteiron confervicola.* A well-developed thallus; a female gamete forming in the large cell (420), p. 230.

6. A vegetative filament (448).

7. Male gametes forming in one cell (420).

INDEX

Names of species and genera which are only casually mentioned and those considered doubtful in respect to their occurrence in this country or their validity are printed in Roman type; accepted and described species and genera are in SMALL CAPITALS, and synonyms in *italics*. The page on which the technical treatment appears is printed in **full-face**.



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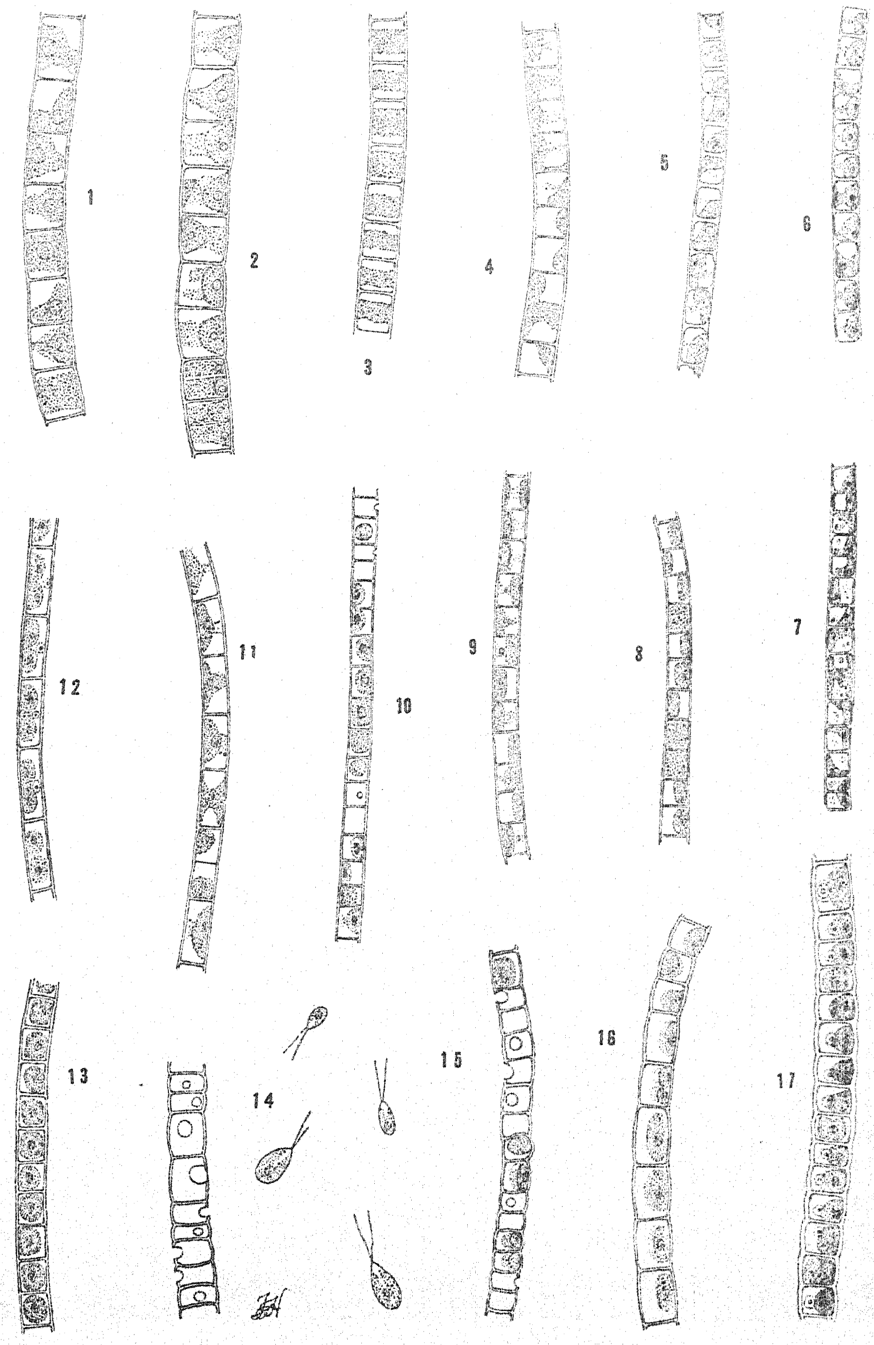

1,2. ULOTHRIX IMPLEXA. 3,4. U. TENERRIMA. 5-7. U. VARIABILIS.
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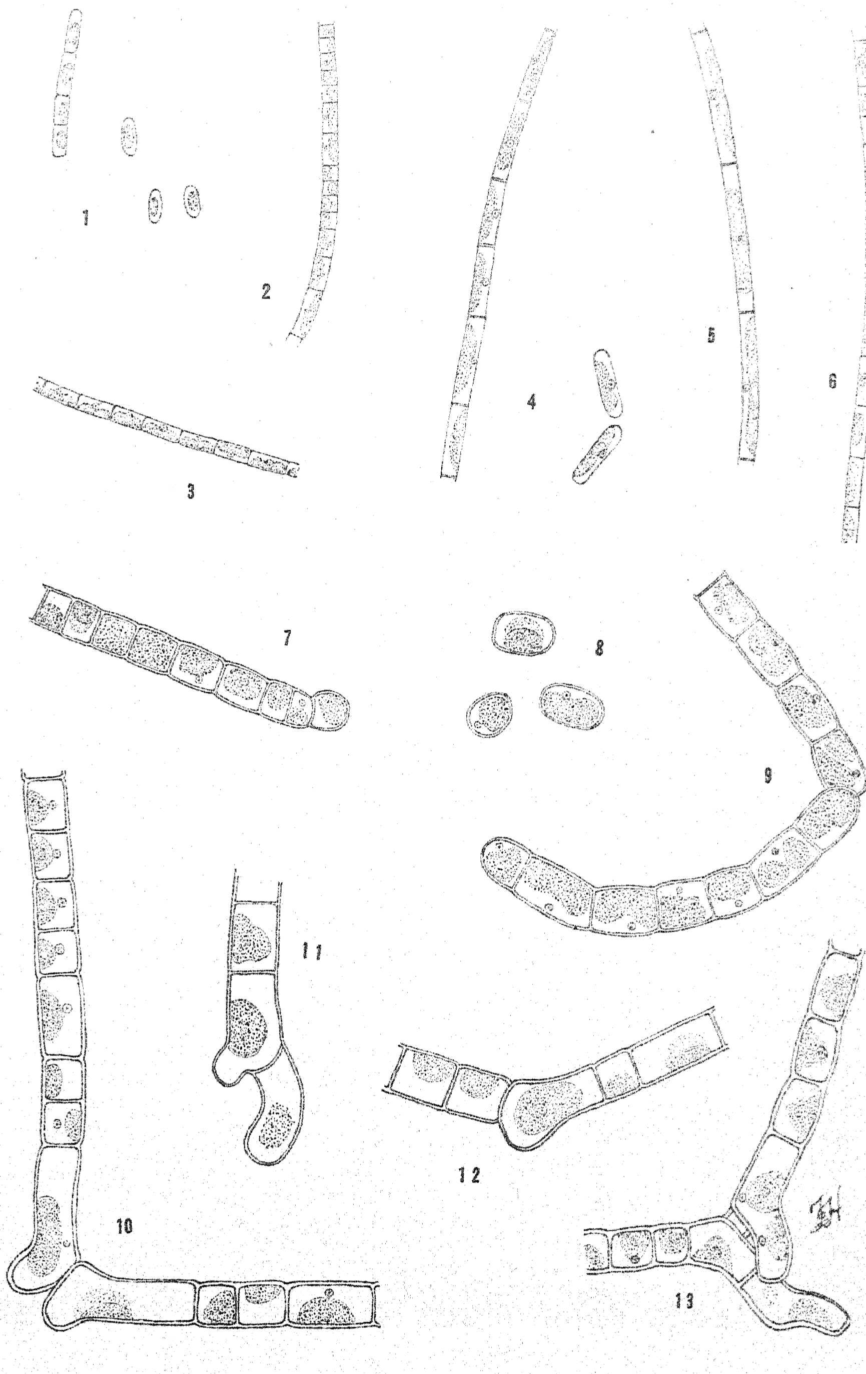

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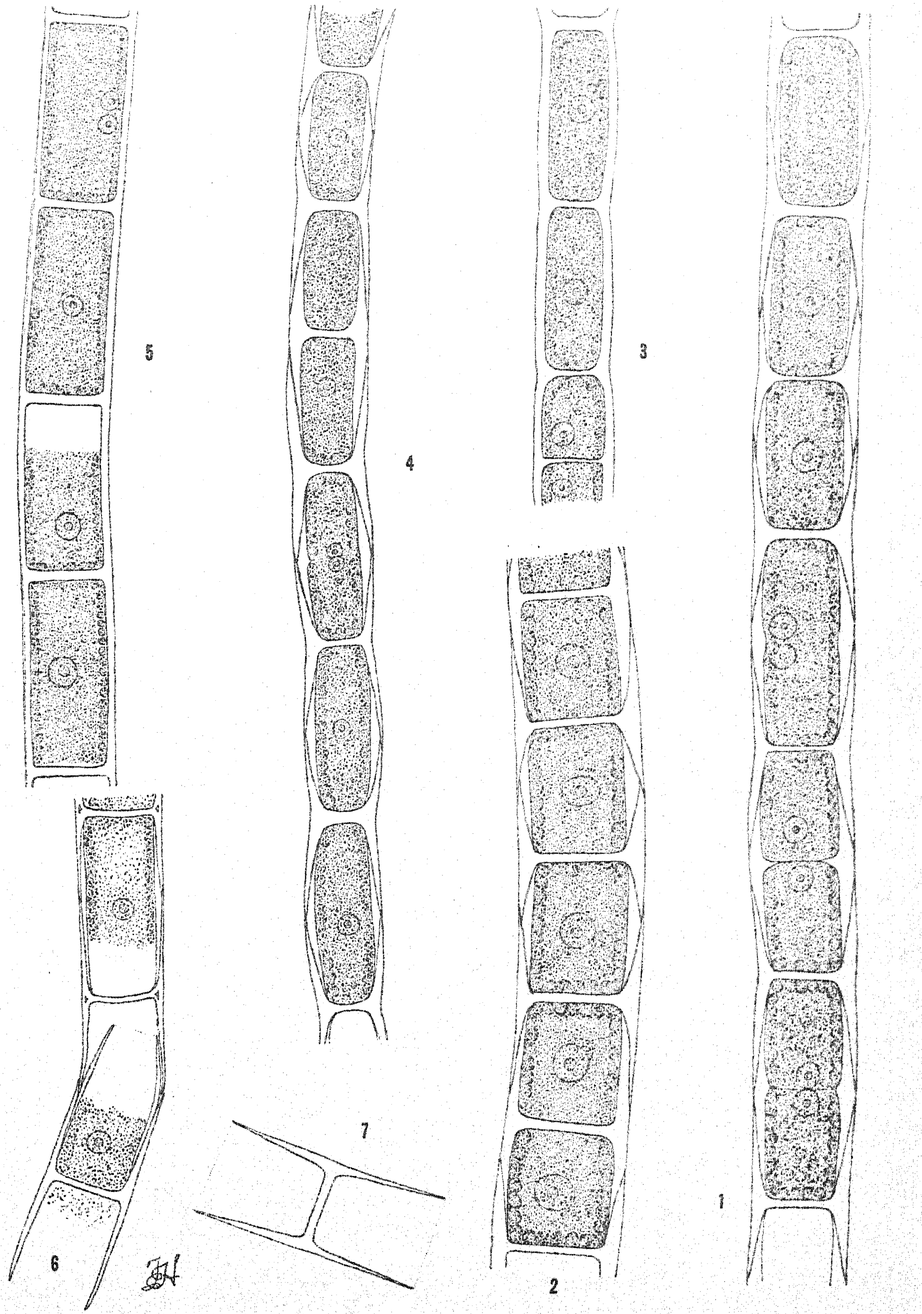
10-13. S. RIVULARIS



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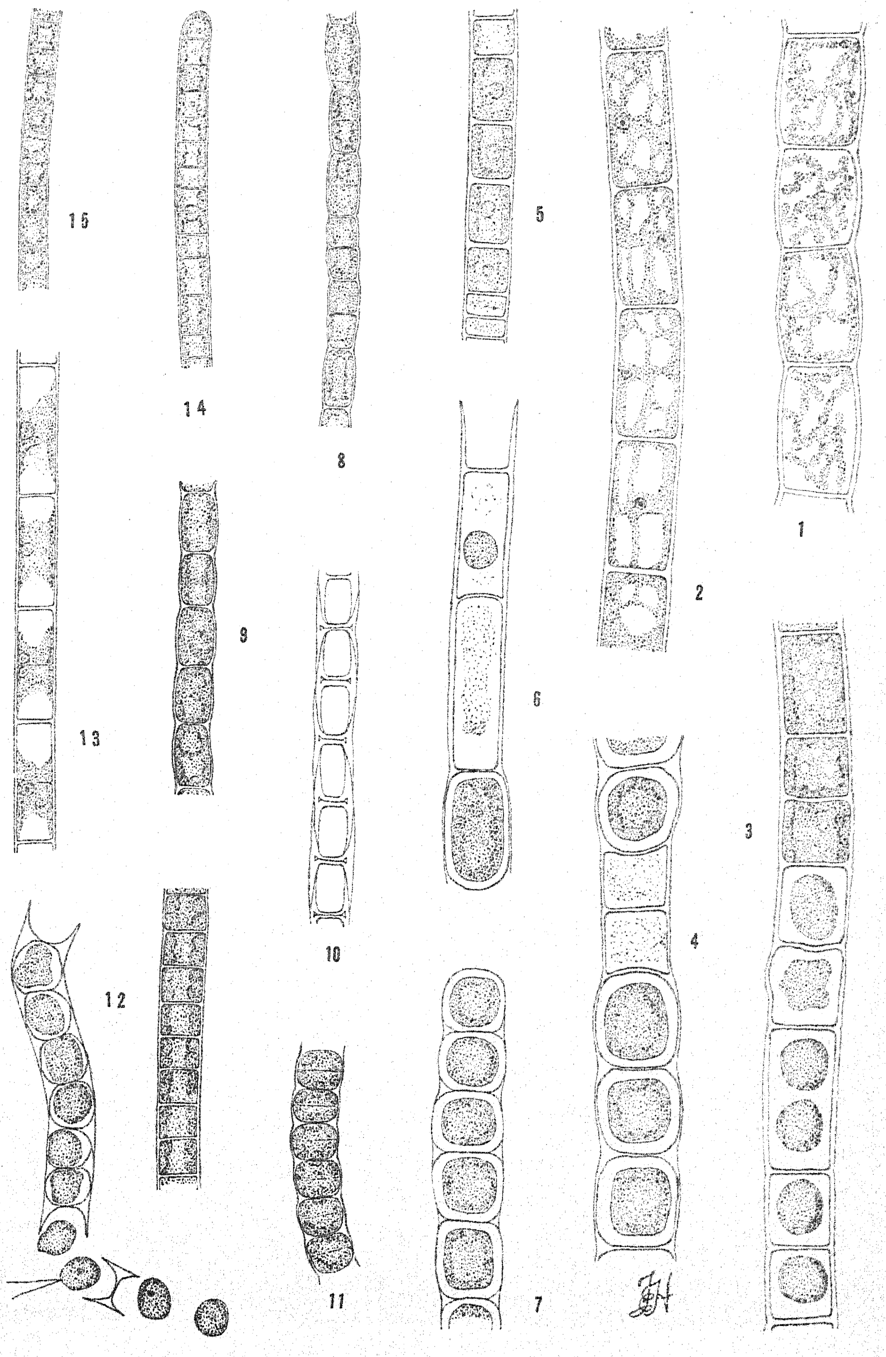
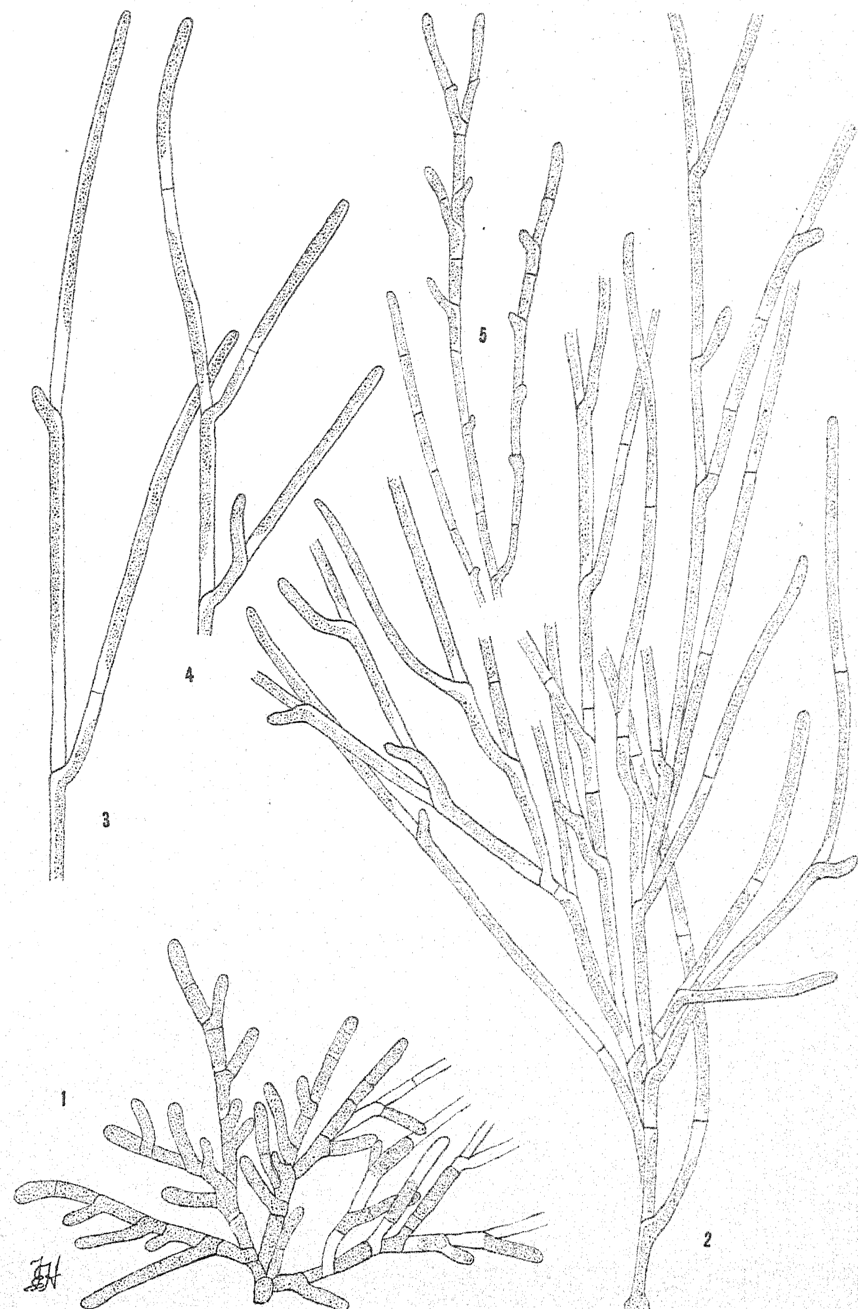
5-7. M. WITTROCKII



1-4. MICROSPORA FLOCCOSA. 5-7. M. WILLEANA. 8-11. M. TUMIDULA.
12,13. M. STAGNORUM. 14,15. M. QUADRATA.

1-6. TRIBONEMA BOMBYCINUM. 7,8. T. MINUS. 9-11. T. UTRICULOSUM



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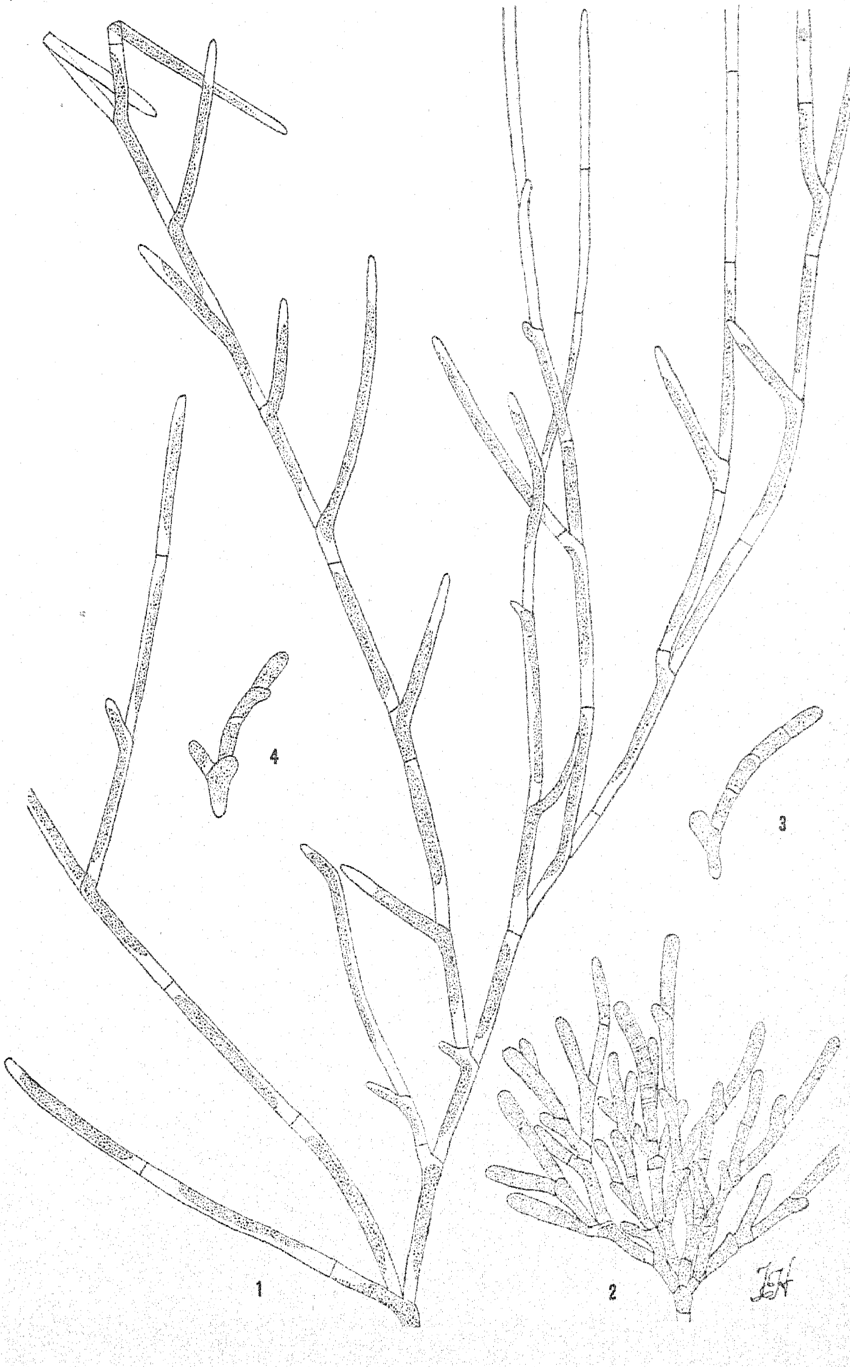

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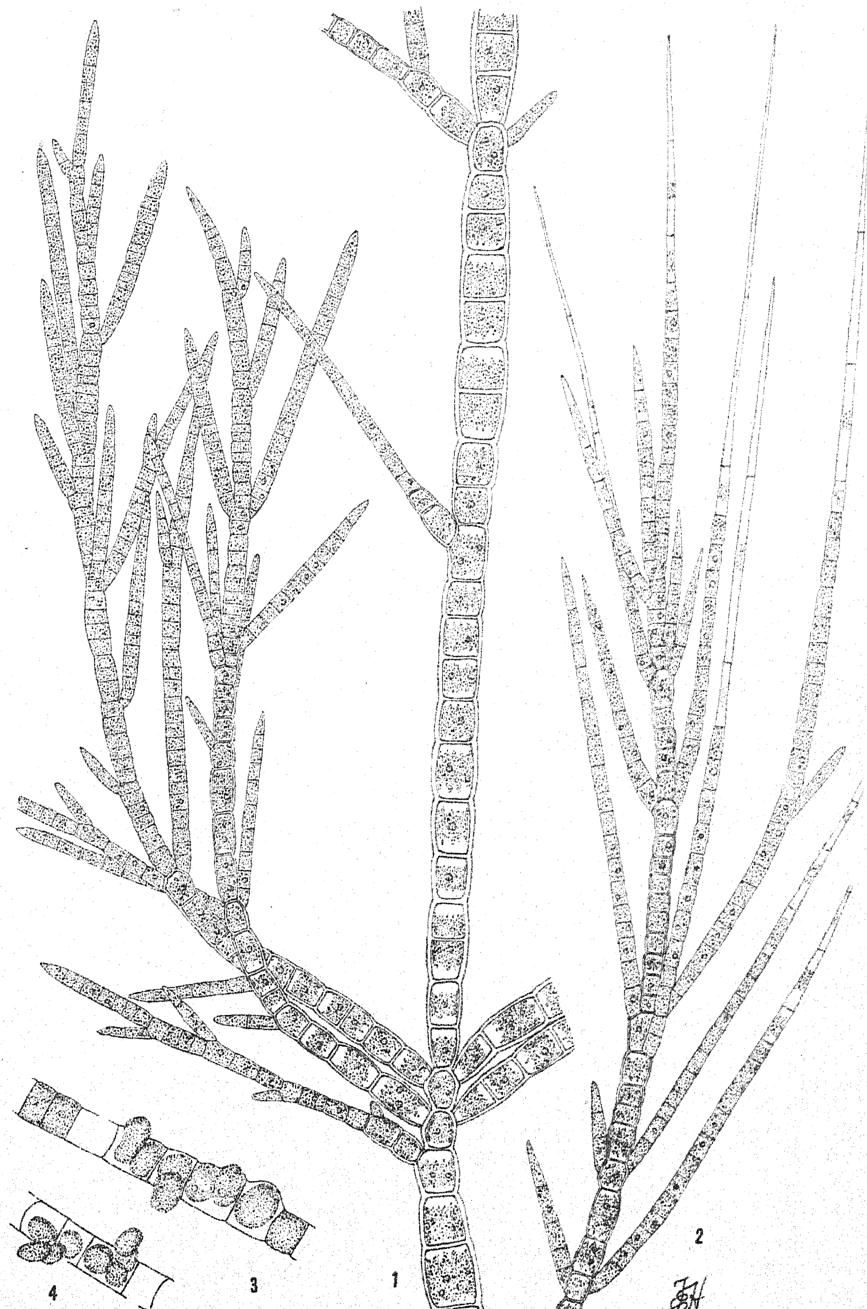
2-4. M. KUETZINGIANUM



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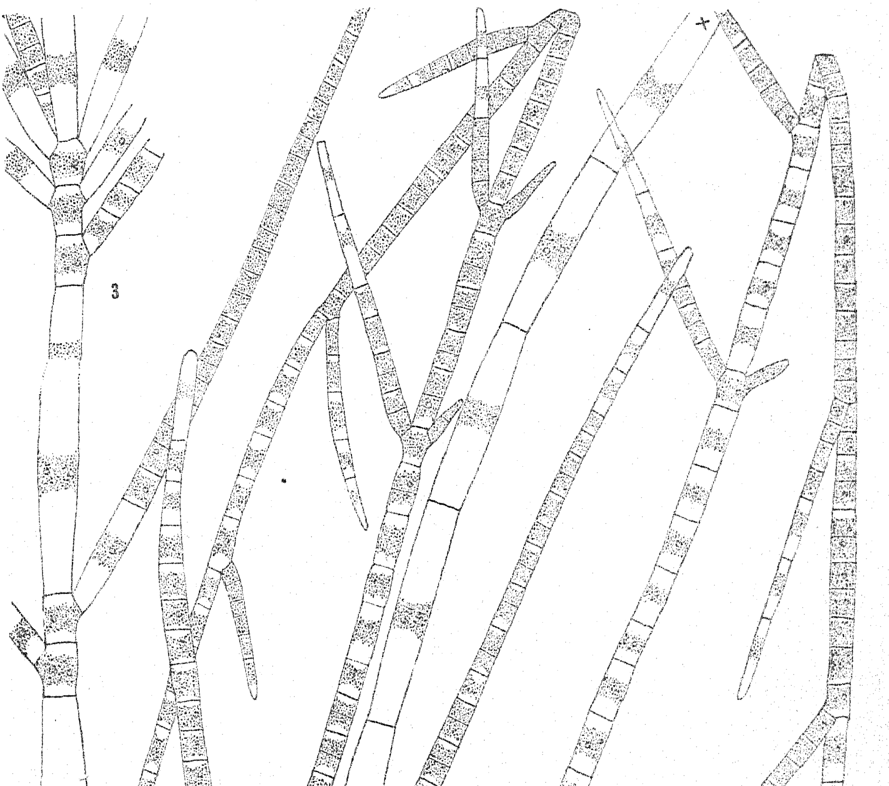

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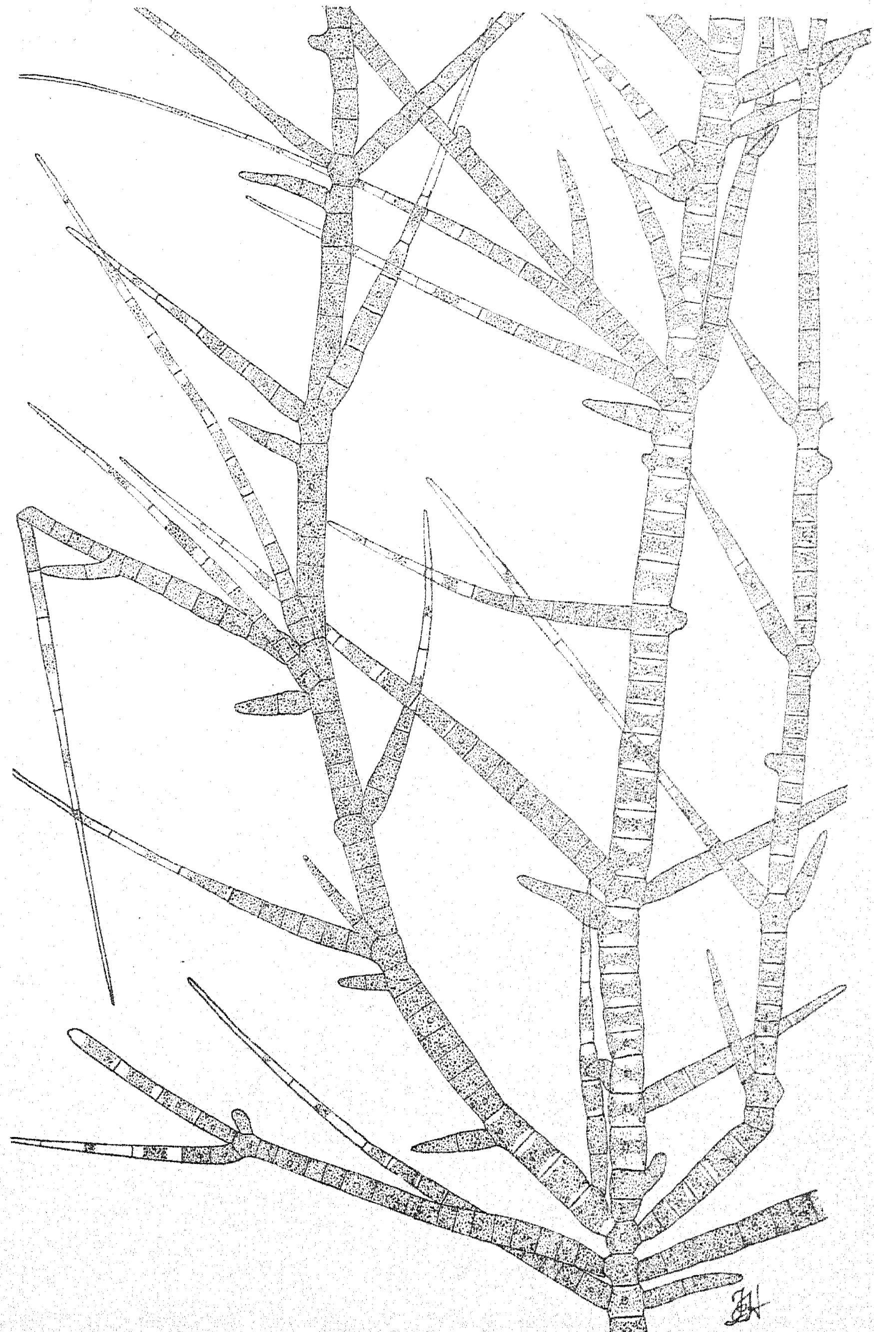

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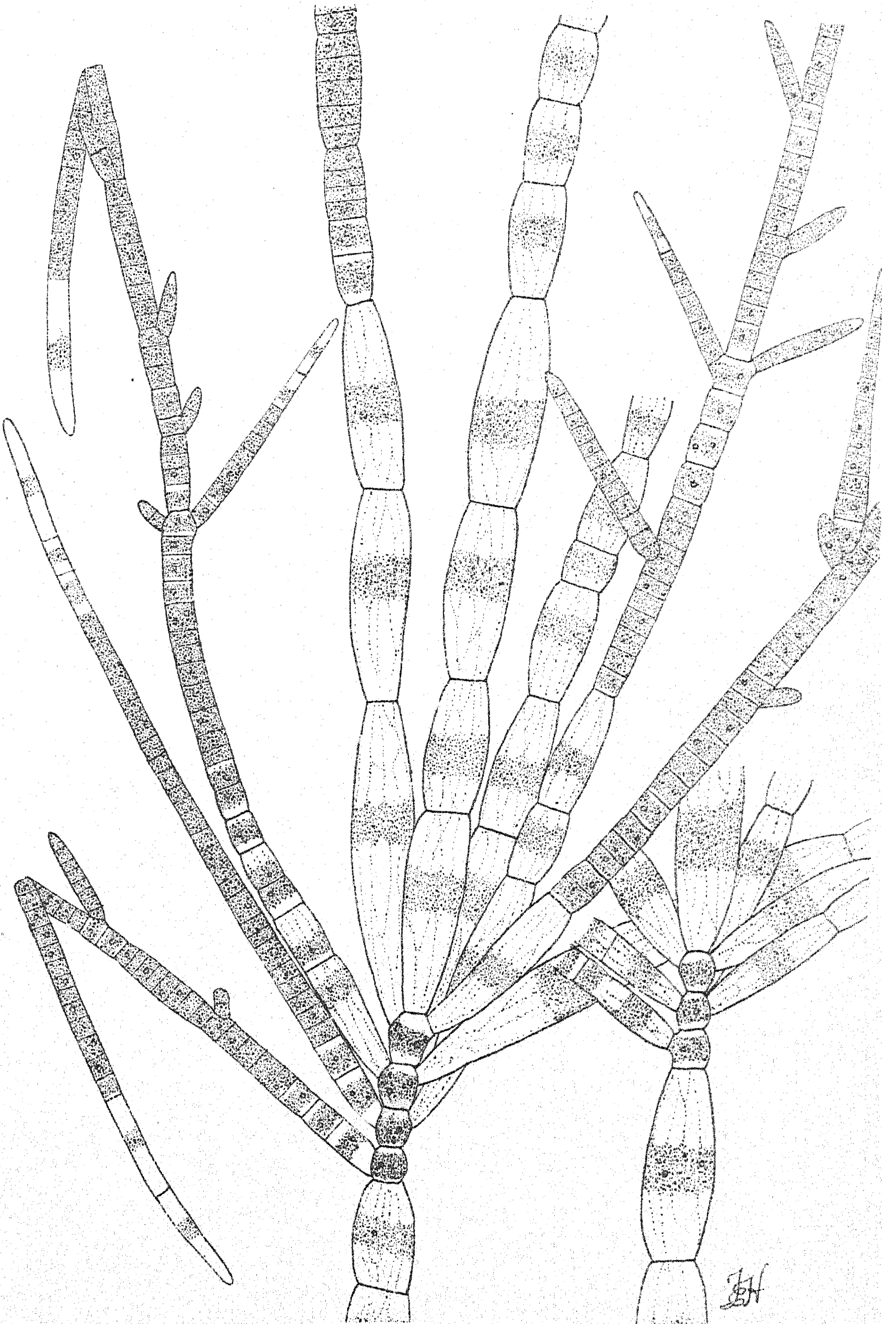

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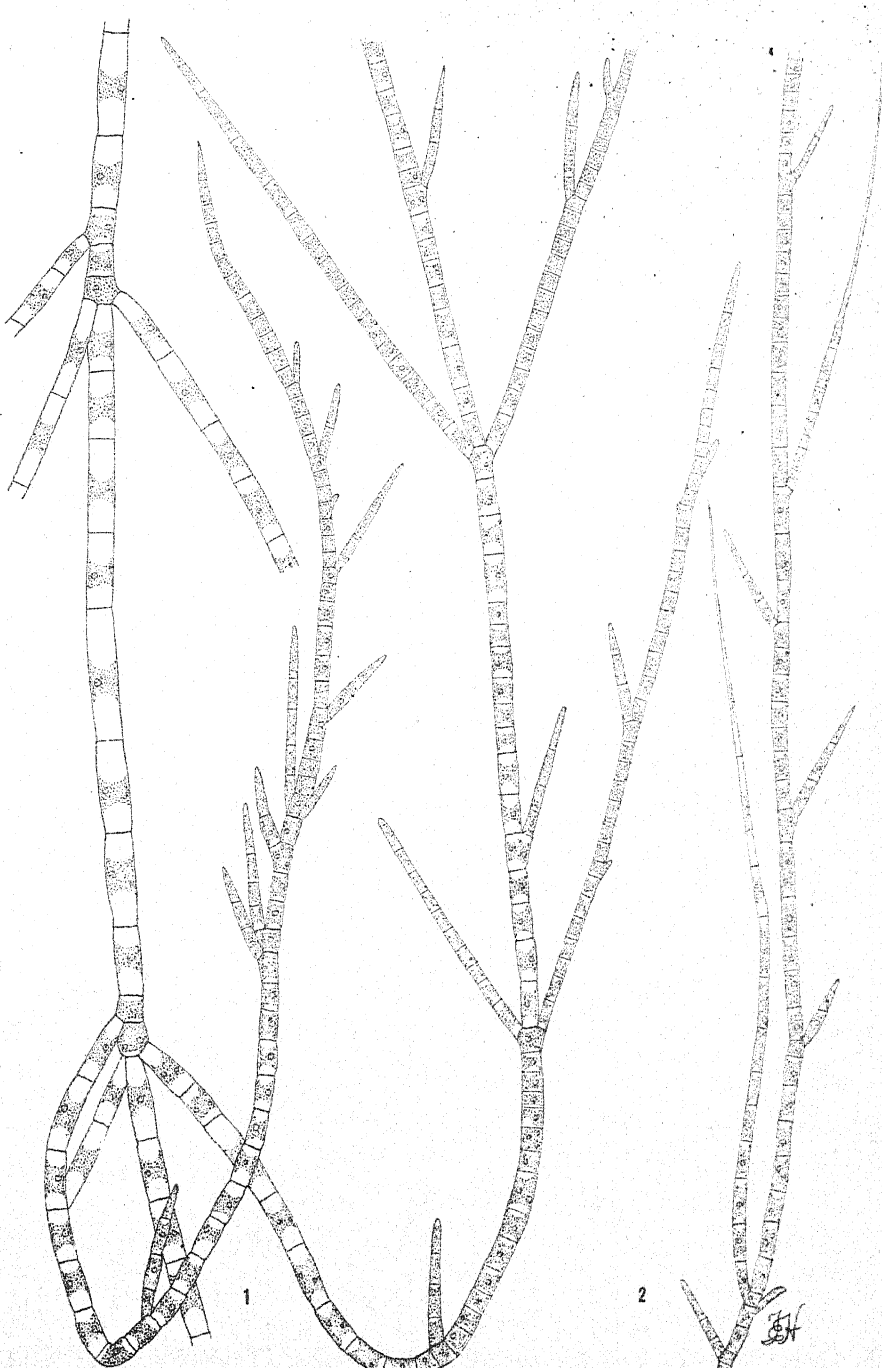

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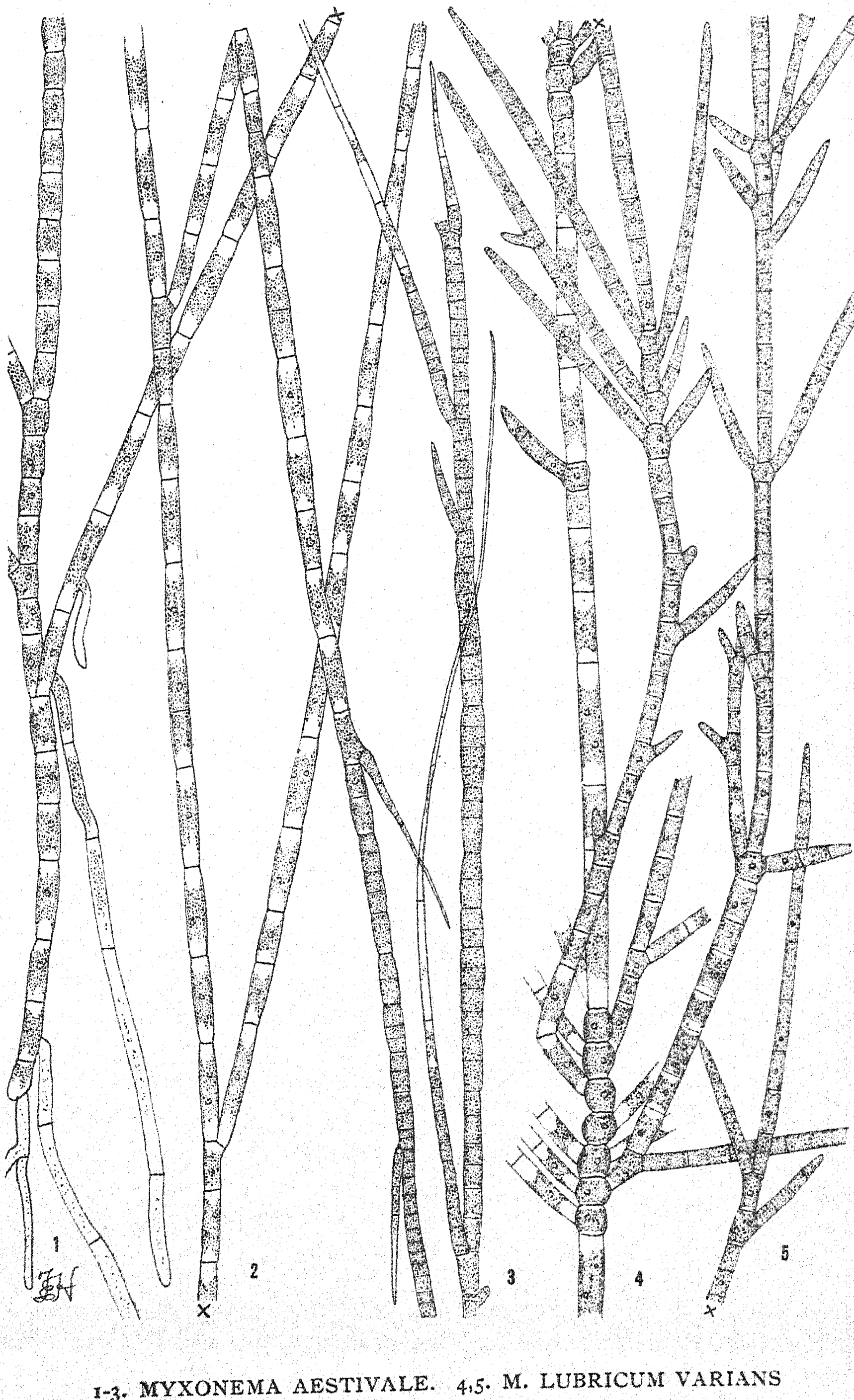

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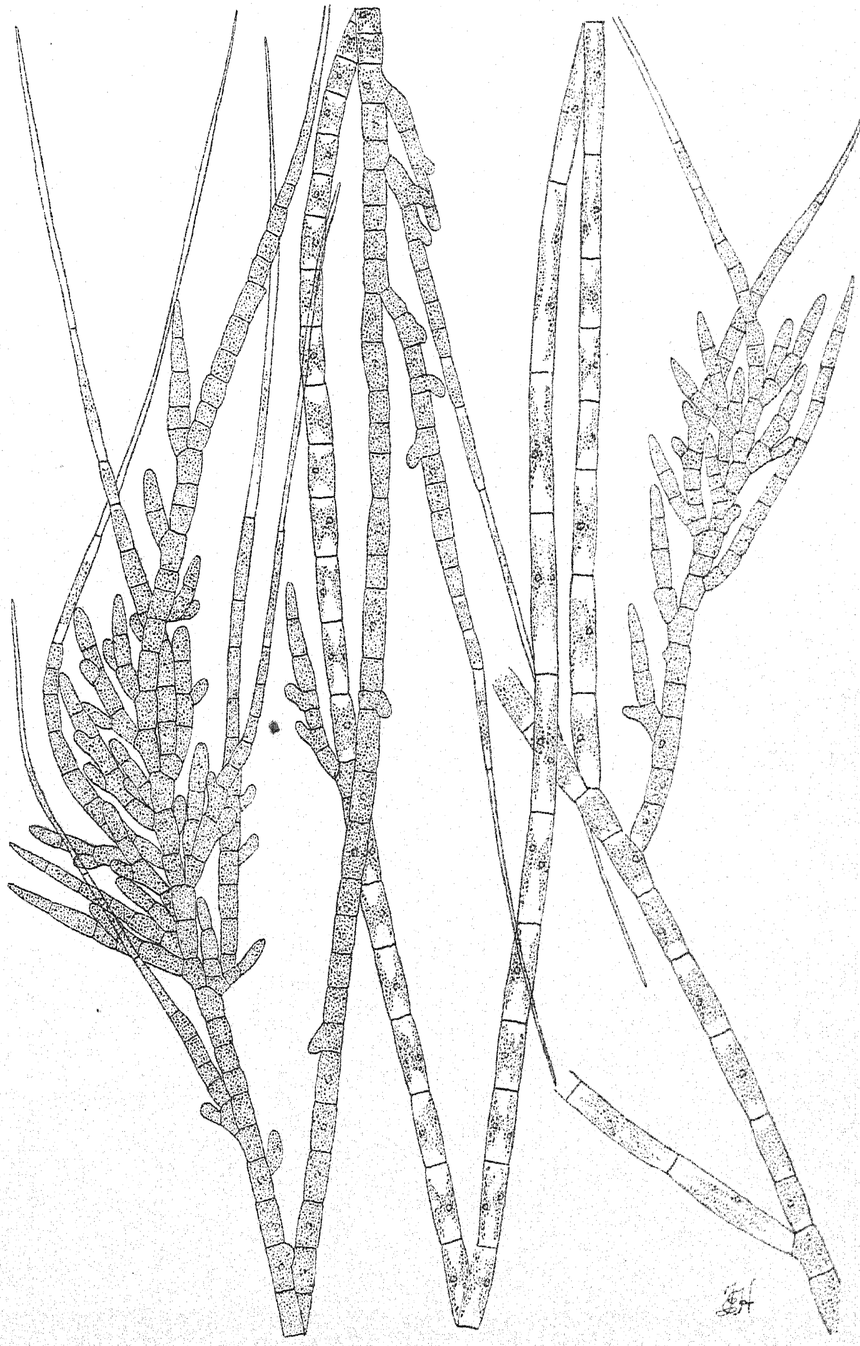

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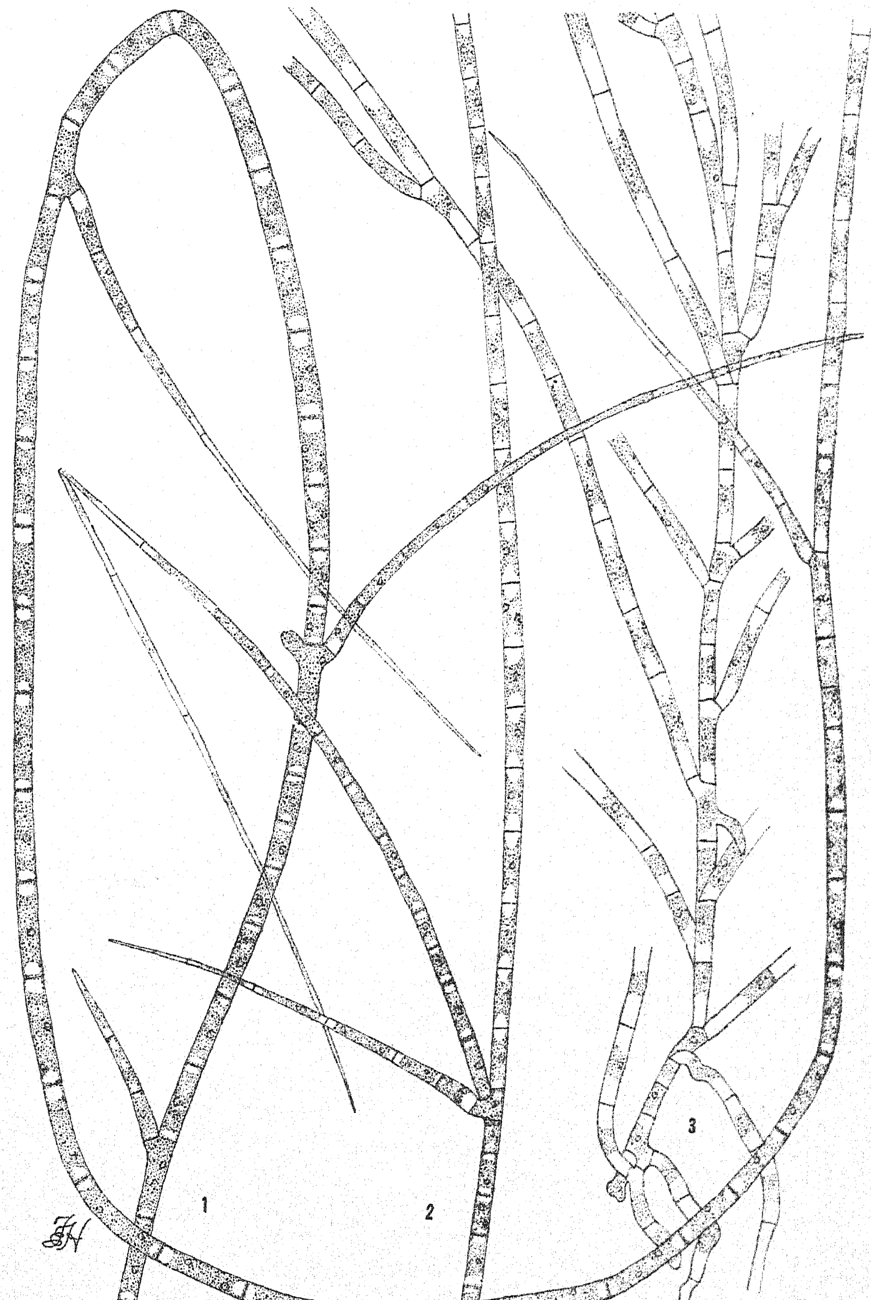

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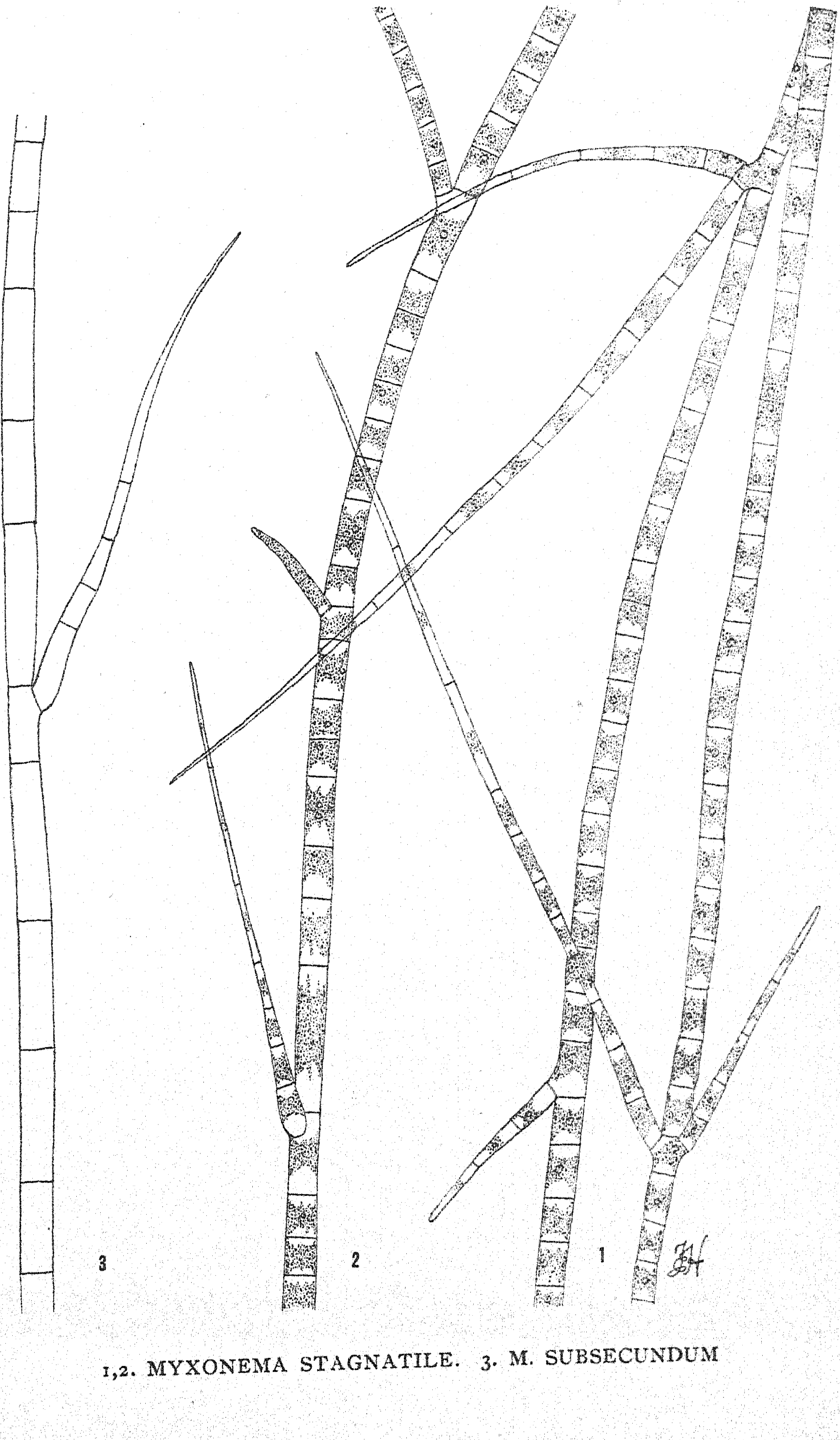

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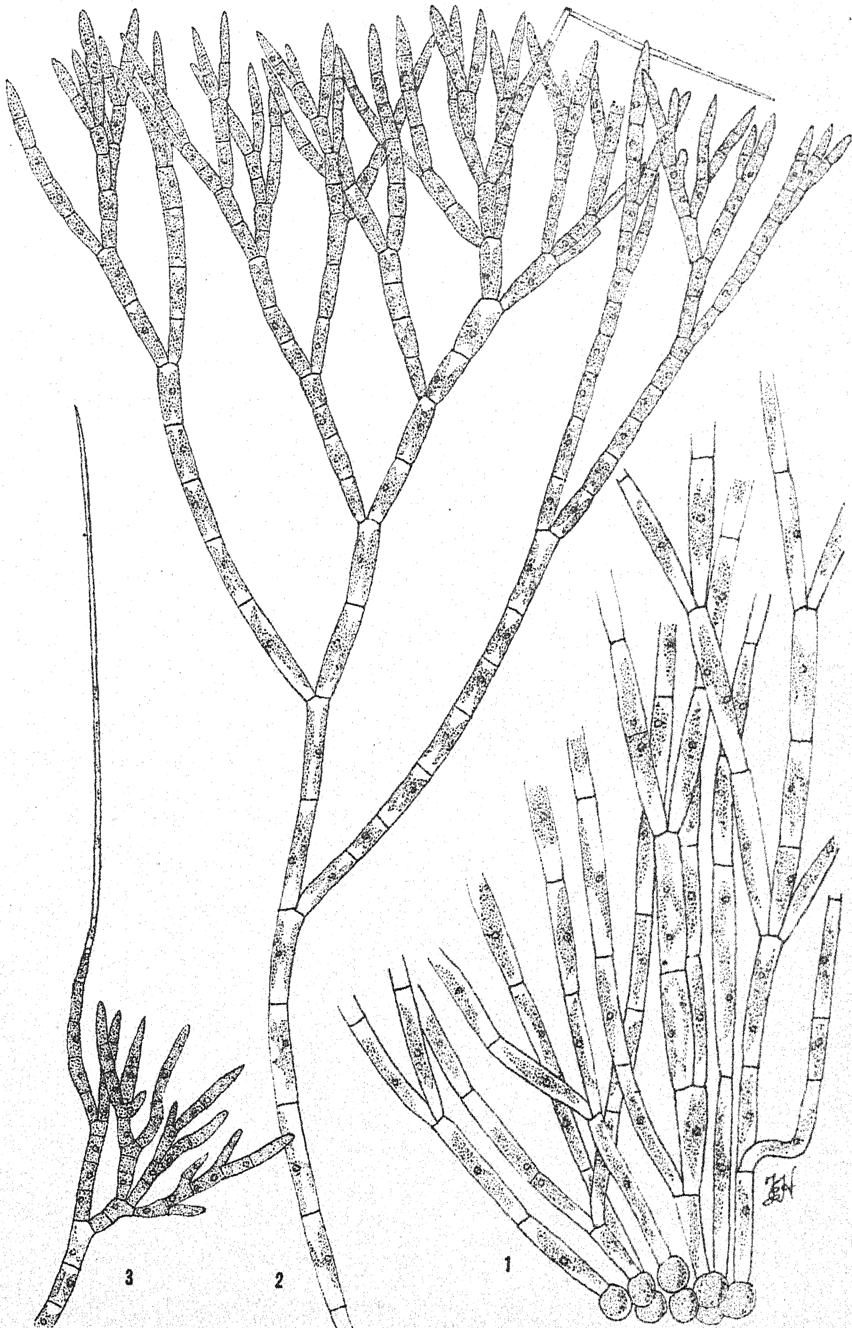

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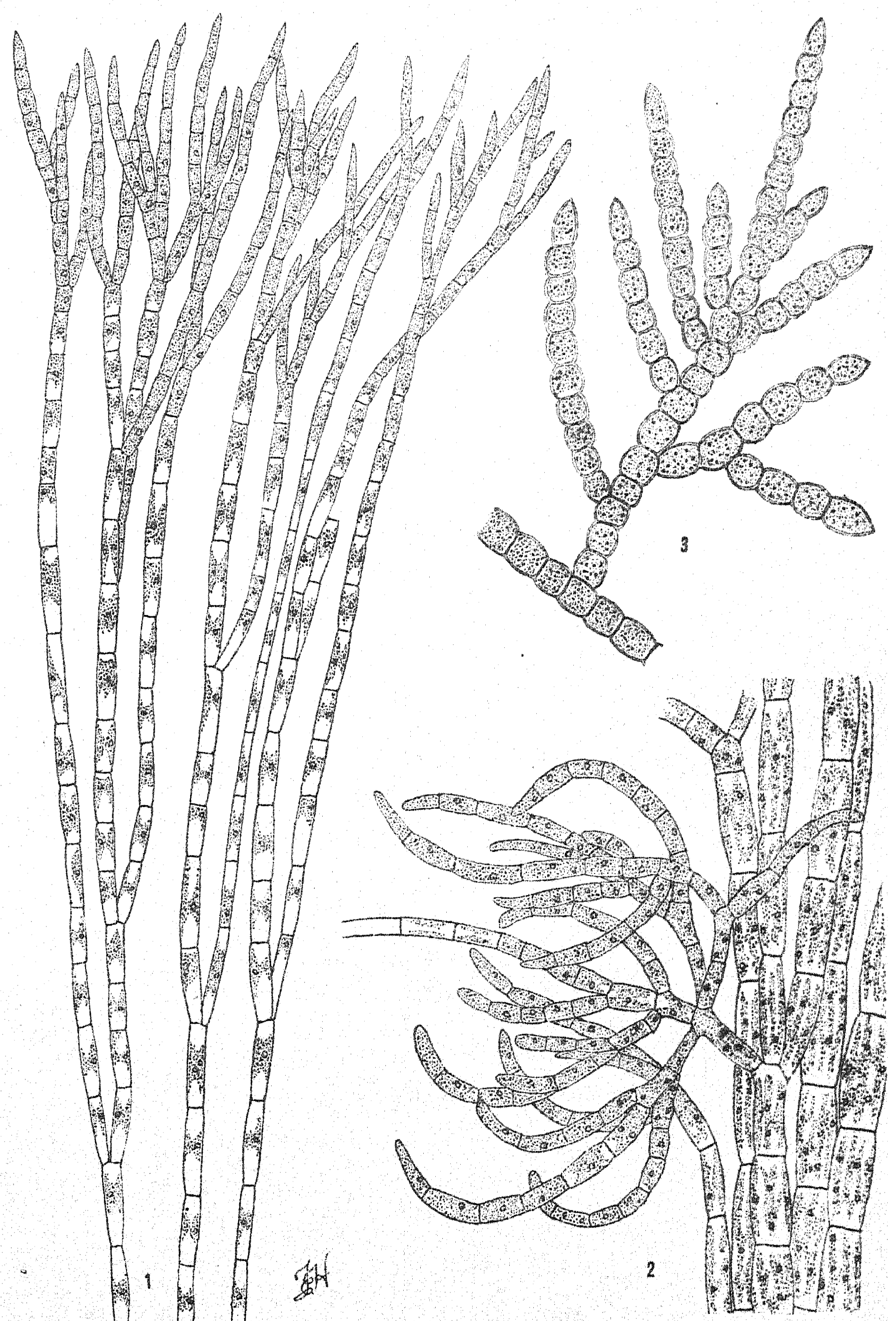

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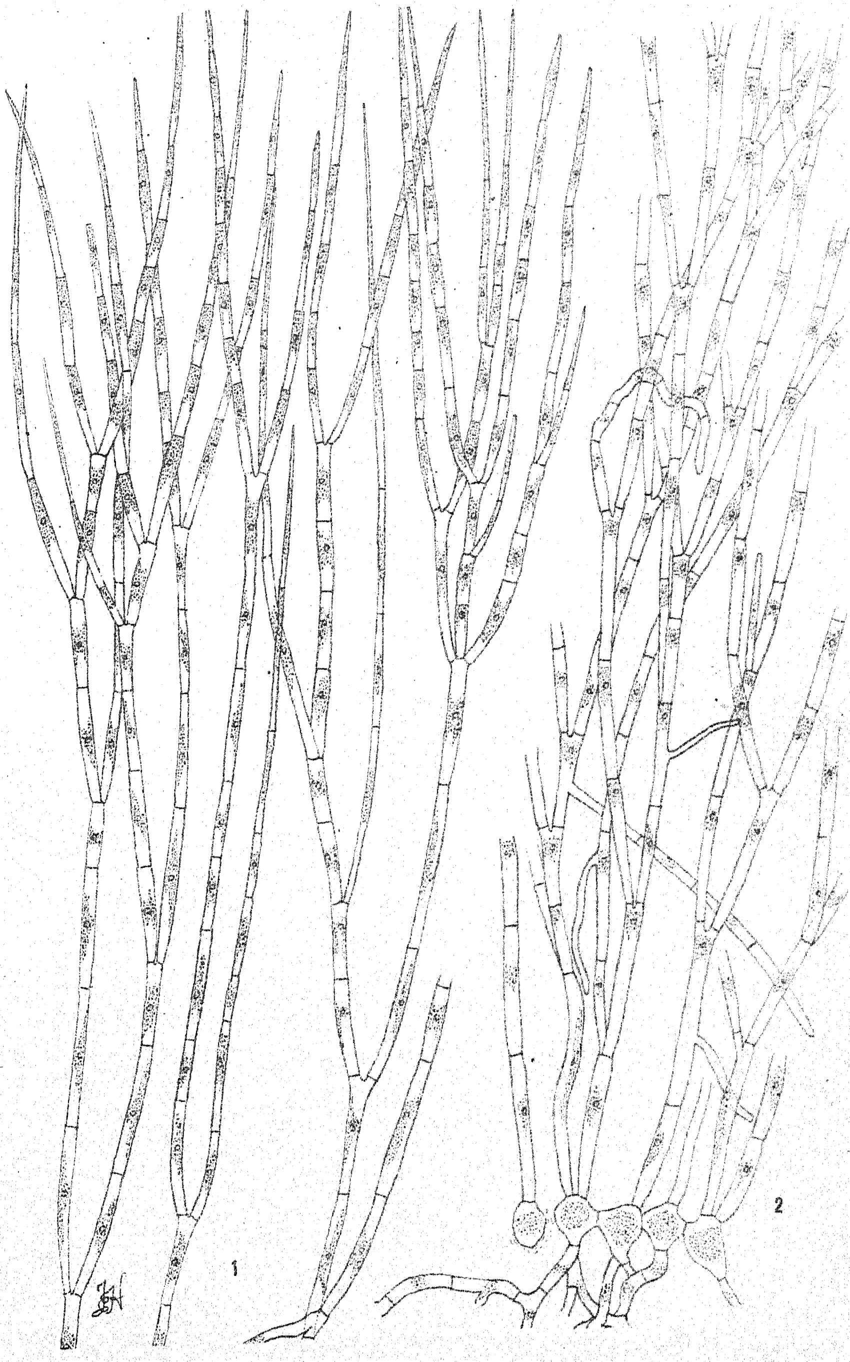
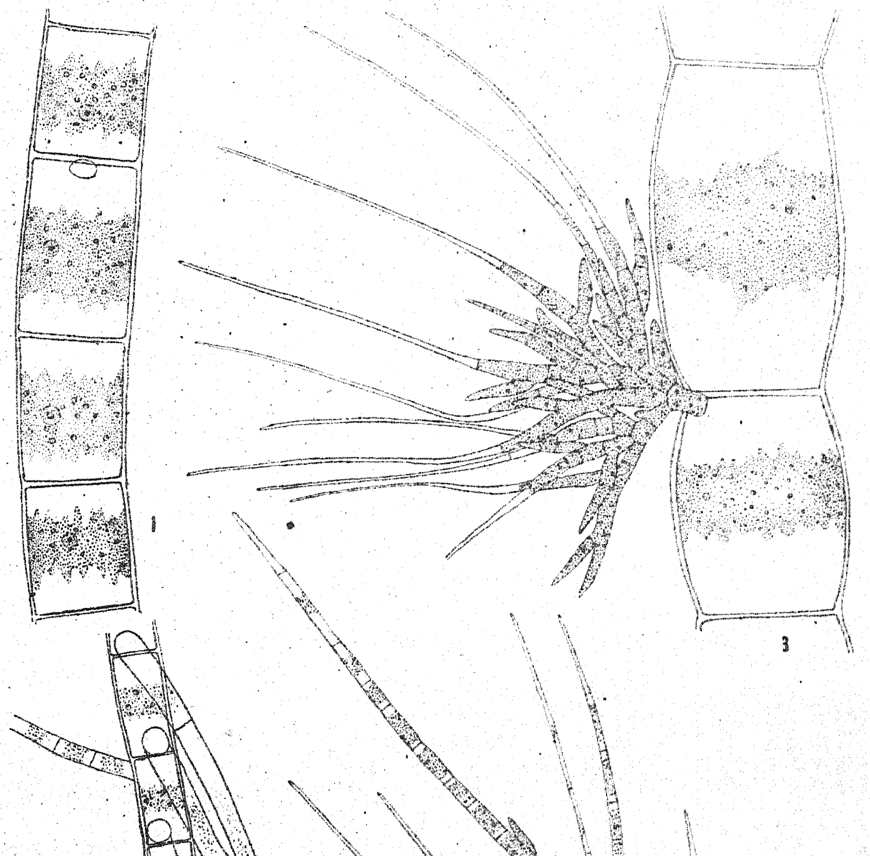


CHAETOPHORA ATTENUATA

HELIOTYPE CO., BOSTON.



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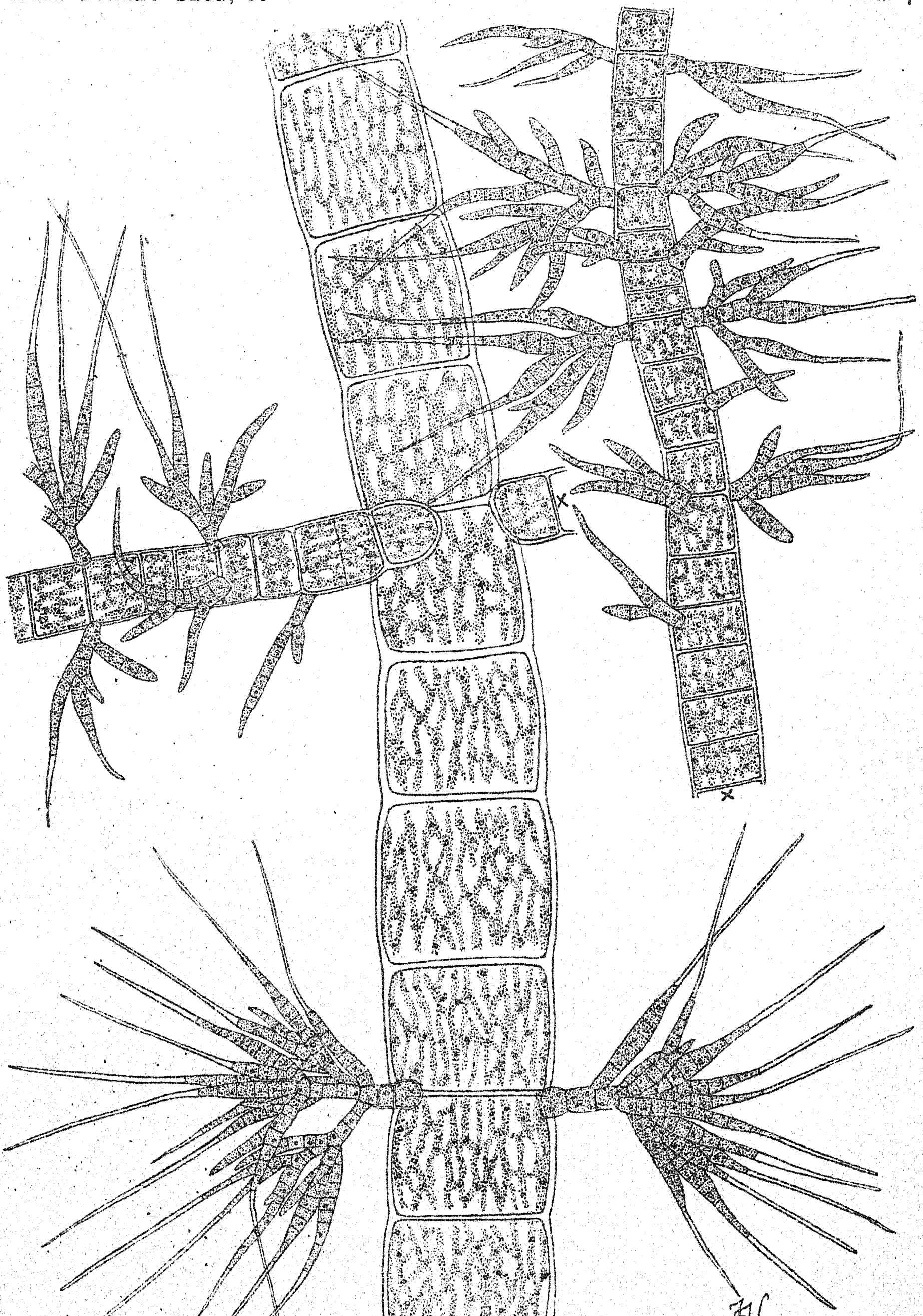

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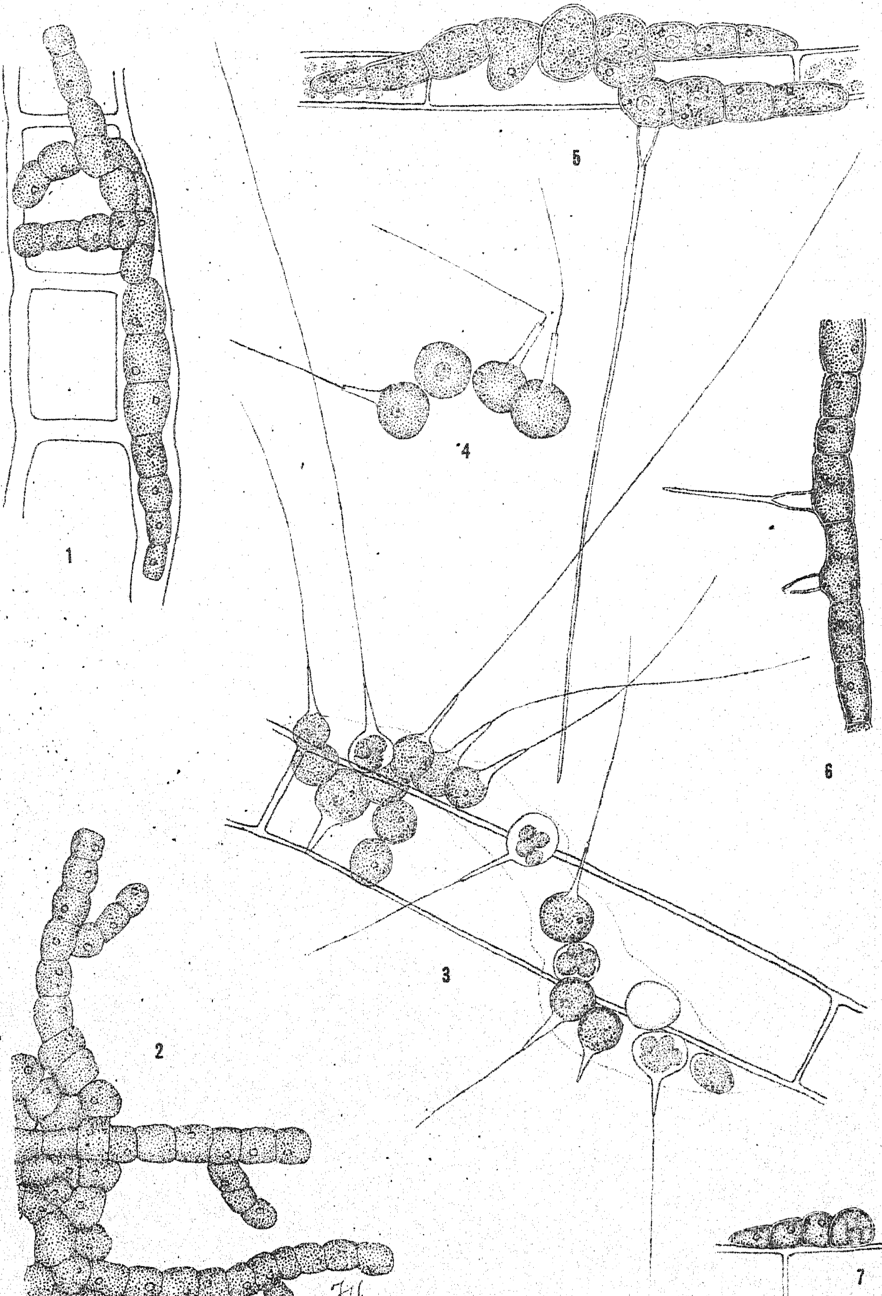

1. ENDODERMA. 2. EPICLADIA. 3,4. CHAETOSPHAERIDIUM.
5-7. HERPOSTEIRON